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The LARSYS Educational Package: Instructors Notes for Use with the Data 100

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16 Abstract The LARSYS Educational Package is a set of instructional materials developed to train people to analyze remotely sensed multispectral data using LARSYS, a computer software system developed at LARS/Purdue. The materials included in this volume have been designed to assist LARSYS instructors as they guide students through the LARSYS Educational Package. All of the materials have been updated from the previous version (information note 110574) to reflect the use of a Data 100 Remote Terminal.					
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LARSYS EDUCATIONAL PACKAGE

INSTRUCTOR'S NOTES

FOR USE WITH DATA 100

by

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James D. Russell

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Purdue University, West Lafayette, Indiana 47907.

PREFACE

The materials included in this volume have been designed to assist LARSYS instructors as they guide students through the LARSYS Educational Package. All of the materials have been updated from the previous version (Information Note 110574) to reflect the use of a DATA 100 Remote Terminal.

Included in the material is "A Survey of the LARSYS Educational Package for use with a DATA 100 Remote Terminal," the revised Student Notes for Units II through V (Units I, VI, VII, and VIII have been issued as separate LARS Information Notes) and the Instructor's Notes for each of the eight units now in the package. Instructor's Notes are printed on buff paper.

There are many changes in the Educational Package to reflect the use of a DATA 100 Remote Terminal in place of the 2780. Units I and II are unchanged since they are general in nature and do not deal specifically with the remote terminal. Unit III has been modified to facilitate demonstration of the DATA 100. The most extensive changes are in Unit IV since the user is getting "Hands-On" experience with the DATA 100 Remote Terminal. In Unit IV, the user learns to use the system to communicate with the operator and with other users, and is designed to be used with either a 2741 Typewriter or a CRT Typewriter. Most of the changes reflect procedures for using the DATA 100 instead of the 2780. The exercises in Unit V have not been changed since the user can complete the same activities on the DATA 100.

Unit VI, Guide to Multispectral Data Analysis Using LARSYS, and Unit VII, A Case Study Using LARSYS for Analysis of Landsat Data, have not been changed. A totally new addition to the Educational Package is Unit VII, A Case Study Using ECHO for Analysis of Multispectral Scanner Data. It has been designed by Donna Scholz, James Russell, John Lindenlaub and Philip Swain and is similar in format to Units VI and VII. ECHO (Extraction and Classification of Homogeneous Objects) is a newly developed classification algorithm.

A Survey of the LARSYS Educational Package for Use with a DATA 100 Remote Terminal

The LARSYS Educational Package is a set of instructional materials developed to train people to analyze remotely sensed multispectral data using LARSYS, a computer software system developed at LARS/Purdue. A high priority was placed on designing the materials for independent study as it has been found that this is the most likely situation in practice. Organizations just getting started in the use of multispectral data usually have only two or three people making initial use of LARSYS. As their experience and skills improve, other workers join the effort. Users start at different times and, depending on their backgrounds and other duties, progress at different rates.

A series of eight units has been developed. Each unit is designed to take a student from an initial point, defined by the prerequisites, to an end point, defined by its objectives. Each unit provides informational materials, an opportunity for the student to practice and study the skills or ideas presented, and a problem or test situation to help him determine whether he has met the objectives of that unit.

A variety of media is used in the educational package, the selection dependent on the nature of the material and the defined objectives of each unit. Reinforcement of certain concepts, such as the multispectral concept and the multidimensional statistical approach, is interwoven throughout the package.

Essential to the effective use of the educational package is a "LARSYS expert" or "site expert." Each student should be assigned to one or two persons experienced with LARSYS who can serve as instructors. At LARS/Purdue the instructor would probably be a fellow researcher from within the same program area. At geographically remote sites, the "site expert" would be an individual who has spent anywhere from several days to several weeks at LARS learning about LARSYS. While at LARS he would have had the opportunity to go through the training materials while working with a terminal identical to his remote site terminal and to observe operations in the computer facility. As the number of experienced LARSYS users at a given remote site grows, it is expected that some of them will also assume instructional duties. Instructor notes, designed to assist those serving as instructors, accompany each unit.

The function of the instructor is not to plan and preside over formal classroom sessions, but rather to serve as a tutor helping clarify troublesome points for each student. It is intended that student/instructor sessions be brief with the instructor providing the necessary corrective feedback or encouragement to enable the student to continue on his own.

Description of the LARSYS Educational Package

The LARSYS Educational Package presently consists of eight units. A flow chart of the materials is shown on the next page. It summarizes the purpose of each unit and gives a time estimate for completing each unit.

Students begin with a background manual entitled An Introduction to Quantitative Remote Sensing. This is an introduction to remote sensing stressing the role of pattern recognition in numerically-oriented remote sensing systems. Its specific purpose is to provide a common background and orientation for the LARSYS computer software system. For newcomers to remote sensing, this manual introduces concepts and terminology which are needed later on. Remote sensing veterans will be introduced in this material to numerically-oriented remote sensing data analysis.

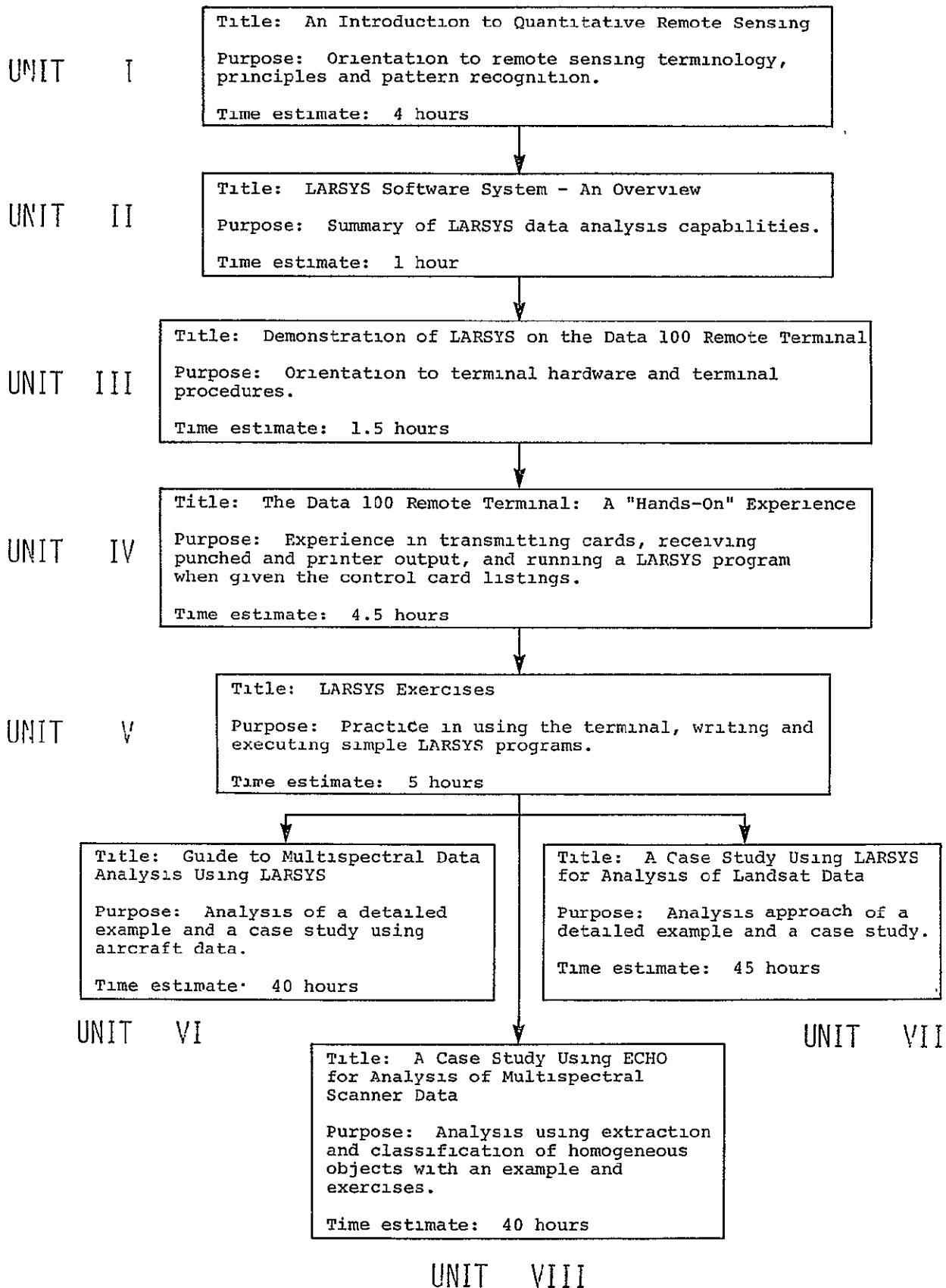
The second unit entitled LARSYS Software System -An Overview consists of a recorded tape which accompanies a display book and student notes. It takes the viewer through a typical remote sensing data analysis sequence and illustrates the commonly used features of the LARSYS processing functions.

An introduction to the computer terminal follows. The unit Demonstration of LARSYS on the DATA 100 Remote Terminal provides the student with an introduction to the data processing hardware that he will be using and introduces him to some additional aspects of the LARSYS software system. He will observe several LARSYS jobs run at the DATA 100 Remote Terminal. The demonstration requires an instructor to present the material and guide the student. Instructor's notes have been designed so that persons with only a modest amount of experience with the terminal can satisfactorily run the demonstration.

Students are instructed in the use of the terminal by means of an audio-tutorial lesson The DATA 100 Remote Terminal: A Hands-On Experience. The student is guided by an audio tape on how to use the terminal off-line as a card lister, login to the computer and initiate the LARSYS system, run sample LARSYS jobs and transmit data to and receive data from the main computer. The audio tape is accompanied by a set of student notes.

LARSYS Exercises, Unit V, are short problems which the student solves by using the computer terminal and LARSYS processing functions. The purpose of these problems is to increase the student's experience in the use of LARSYS for multispectral data analysis and to help him develop an appreciation for the capabilities and limitations of the LARSYS software system.

THE LARSYS EDUCATIONAL PACKAGE



At this point in learning to use LARSYS, the student has a choice between Unit VI, Guide to Multispectral Data Analysis Using LARSYS, Unit VII, A Case Study Using LARSYS for Analysis of Landsat Data and Unit VIII, A Case Study Using ECHO for Analysis of Multispectral Scanner Data. All three units provide a detailed breakdown of the philosophy of the analysis methods -- describing the steps in the analysis, why they are necessary and how they are carried out. A detailed example parallels the description, and the student has the opportunity to carry out an analysis of his own by means of a case study. Unit VI is geared toward a supervised analysis approach and uses aircraft data. Unit VII combines techniques from both supervised and unsupervised approaches and applies these techniques to data collected by the Earth Resources Technology Satellite, now known as Landsat. Unit VIII uses Landsat data, but introduces ECHO (Extraction and Classification of Homogeneous Objects), a newly developed classification algorithm.

Other Educational Resources

A Site Library containing selected LARS Information Notes, the LARSYS User's Manual, "An Analysis of Run 71053900" (an analysis example for Unit VI), "An Analysis of Run 73033802" (an analysis example for Unit VII), "An Analysis of Run 73001011" (an analysis example for Unit VIII), and copies of Focus are included in the support materials accompanying the LARSYS Educational Package.

Two documents in particular are referenced frequently in the LARSYS Educational Package. They are the LARSYS User's Manual edited by T. L. Phillips, and Pattern Recognition: A Basis for Remote Sensing Data Analysis by P. H. Swain. The former document provides a detailed documentation of the LARSYS system from the user's viewpoint; the latter provides a theoretical framework for the algorithms used in the LARSYS processing functions.

Newcomers to the field are encouraged to do some background preparation. The kind and amount of study will vary according to the specific application of remote sensing in which they are interested. A series of nineteen self-study minicourses have been developed at LARS on the fundamentals of remote sensing. The minicourse series is modularized so that after completing two introductory units, the student may study any of the others in the series. Each minicourse includes a set of slides, an audio tape and a printed study guide, and typically requires from 45 to 70 minutes to complete. The student controls the rate and intensity of his study. The student is actively involved in manipulating materials associated with remote sensing, completing exercises and solving problems in the study guide.* Persons new to remote sensing may find it most helpful to look at one or more books written to provide an overview of the field. Generally they discuss the various sensor types, data characteristics, analysis procedures, and applications.

*For additional information on the minicourse series contact:
G.W. O'Brien, Continuing Education Administration
116 Stewart Center, Purdue University
West Lafayette, IN 47907

Those interested may contact Technology Transfer at LARS to determine other educational materials that are available. Additional materials are currently in preparation including additional Focus topics, and video tapes with viewing notes.

Many people have contributed to the development of the LARSYS Educational Package. Valuable suggestions have come from students working with earlier versions of the educational package. You, as a student, can aid in the further development and improvement of the materials by sending any comments and suggestions to:

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Technology Transfer
Laboratory for Applications of
Remote Sensing
1220 Potter Drive
West Lafayette, IN 47906

Remote Sensing of Environment, edited by Joseph Lintz and David Simonett, Addison-Wesley Publishing Company, Reading, Massachusetts, 1976.

Manual of Remote Sensing, edited by R.G. Reeves, American Society of Photogrammetry, Falls Church, Virginia, 1975.

Remote Sensing: the Quantitative Approach, edited by P.H. Swain and S.M. Davis, McGraw-Hill International Book Co., Dusseldorf, Germany, 1978.

Remote Sensing: Techniques for Environmental Analysis, J.E. Estes and L.W. Senger, Hamilton Publishing Co., Santa Barbara, California, 1974.

Remote Sensing: A Better View, R.D. Rudd, Duxbury Press, North Scituate, Massachusetts, 1974.

The Surveillant Science: Remote Sensing of the Environment, edited by R.K. Holz, Houghton, Mifflin Co., Boston, Massachusetts, 1973.

Remote Sensing with Special Reference to Agriculture and Forestry, Committee on Remote Sensing for Agricultural Purposes, National Academy of Sciences, Washington, D.C., 1970.

Special Note to Instructor

Each terminal site has one or more Multispectral Image Storage Tapes assigned to it. The person charged with the responsibility of coordinating educational activities at the site should dedicate one of these tapes to educational purposes. In particular, students will need access to runs 73033802, 66000600, 66005200, 71053900, 72072302, and 73001011 at one or more times as they go through the educational materials. Each site expert is responsible for generating a tape with these runs on it.¹ This may be accomplished by means of the following LARSYS run:

```
*DUPLICATERUN
FROM RUN (73033802)
TO TAPE(TTT), FILE(1)
END
*DUPLICATERUN
FROM RUN(66000600)
TO TAPE(TTT), FILE(2)
END
*DUPLICATERUN
FROM RUN(66005200)
TO TAPE(TTT), FILE(3)
END
*DUPLICATERUN
FROM RUN(71053900)
TO TAPE(TTT), FILE(4)
END
*DUPLICATERUN
FROM RUN(72072302)
TO TAPE(TTT), FILE(5)
END
*DUPLICATERUN
FROM RUN(73001011)
TO TAPE(TTT), FILE(6)
END
```

where TTT is the tape number used for educational purposes at your particular site.

¹This particular order was chosen so as to place the run expected to have heaviest use at the beginning of the tape. This results in fewer file forward requirements and hence more efficient operation. Local conditions or case study preferences may dictate a different order at your remote terminal site.

AN INTRODUCTION TO
QUANTITATIVE REMOTE SENSING

Instructor's Notes

Materials Required: Student's personal copy of
An Introduction to Quantitative Remote Sensing
(LARS Information Note 110474)

Estimate of Instructor time required: Briefing time:
5 to 10 minutes

Important Notes:

An Introduction to Quantitative Remote Sensing is written like a programmed text. Urge your student to read the Preface first. The material is self-contained and the reader should require no external assistance. Each student should be provided with a personal copy.

The booklet is divided into three sections: I. An Introduction to Remote Sensing, II. Multispectral Analysis and III. The Role of Pattern Recognition in Remote Sensing. Each section is preceded by Objectives and a Pretest (blue page) and followed by a Posttest (yellow pages). The answers for all of the Pretest and Posttest questions are given in the Appendix (pink pages). Encourage the student to actually write out each answer in the spaces provided in the booklet. On the basis of the "correctness" of his answers to these questions, he will be directed to various parts of the text.

Instructors who have used this booklet feel that debriefing students after the Introduction is very important, especially to be sure that they understand the basic concepts such as decision rules.

If your student is a newcomer to remote sensing, you might suggest additional reading from the Site Library. Select materials that emphasize the discipline orientation of the student.

THE LARSYS SOFTWARE SYSTEM:
AN OVERVIEW

Instructor's Notes

Materials Required: Audio tape and tape player
Booklet of displays
Three decks of computer cards (A,B and C)
Student Notes handout (which student will
keep)

Estimate of Instructor time required: Briefing time:
5 to 10 minutes

Students should be briefed on the operation of the tape player.

You should emphasize this is an overview and that it is not intended that the students absorb all the details. Have them pay close attention to the set of instructional objectives stated at the beginning of the Student Notes.

—

Student Notes
for
LARSYS
software system:
An Overview

*LINEGRAPH *SEPARABILITY
*PICTUREPRINT
*HISTOGRAM
LARSYS
*CLASSIFYPOINTS *IDPRINT *STATISTICS
*PRINTRESULTS

Developed by James D. Russell and John C. Lindenlaub

Laboratory for Applications of Remote Sensing
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NOTE TO THE STUDENT: This set of notes is designed to accompany an audio tape, a set of display materials and three sample decks, labeled A, B and C. The presentation runs about 45 minutes and is intended as an overview or introductory treatment of the LARSYS software system.

If you have not done so already, begin this minicourse by listening to the audio tape and following the instructions given on the tape. Music on the tape will be your cue to turn off the tape and perform some activity.

PREREQUISITES: Some background in remote sensing and pattern recognition is assumed. Specifically you should be able to:

1. Define "remote sensing."
2. Identify three types of measurable electromagnetic field variations that are used in remote sensing.
3. Given a graph showing relative spectral response vs. wavelength for various ground covers, plot their associated points on the λ_1, λ_2 plane.
4. Given a plot of training samples associated with different classes of ground cover, classify an unknown point using a specified decision rule.
5. Outline and/or discuss the basic operation of an airborne multispectral scanner.
6. Given a block diagram of a pattern recognition system, discuss the following terms: receptor, feature vector, categorizer, and decision rule.
7. State two conditions a class must meet in order to be useful.

This background material is included in Unit I of the LARSYS Educational Package, entitled An Introduction to Quantitative Remote Sensing. If you do not feel you have met these prerequisites, you may want to reread sections of the Introduction or get additional suggestions from your instructor.

OBJECTIVES: When you have completed this minicourse, you should be able to

1. List, without regard to the particular format used, the information contained on a multispectral image storage tape.
2. Name the three types of control cards used in running LARSYS programs.
3. Describe the output of at least four of the LARSYS processing functions which are described in this overview.

RETURN TO THE TAPE

WHAT IS LARSYS?

LARSYS - A GROUP OF COMPUTER PROGRAMS DESIGNED TO:

Access

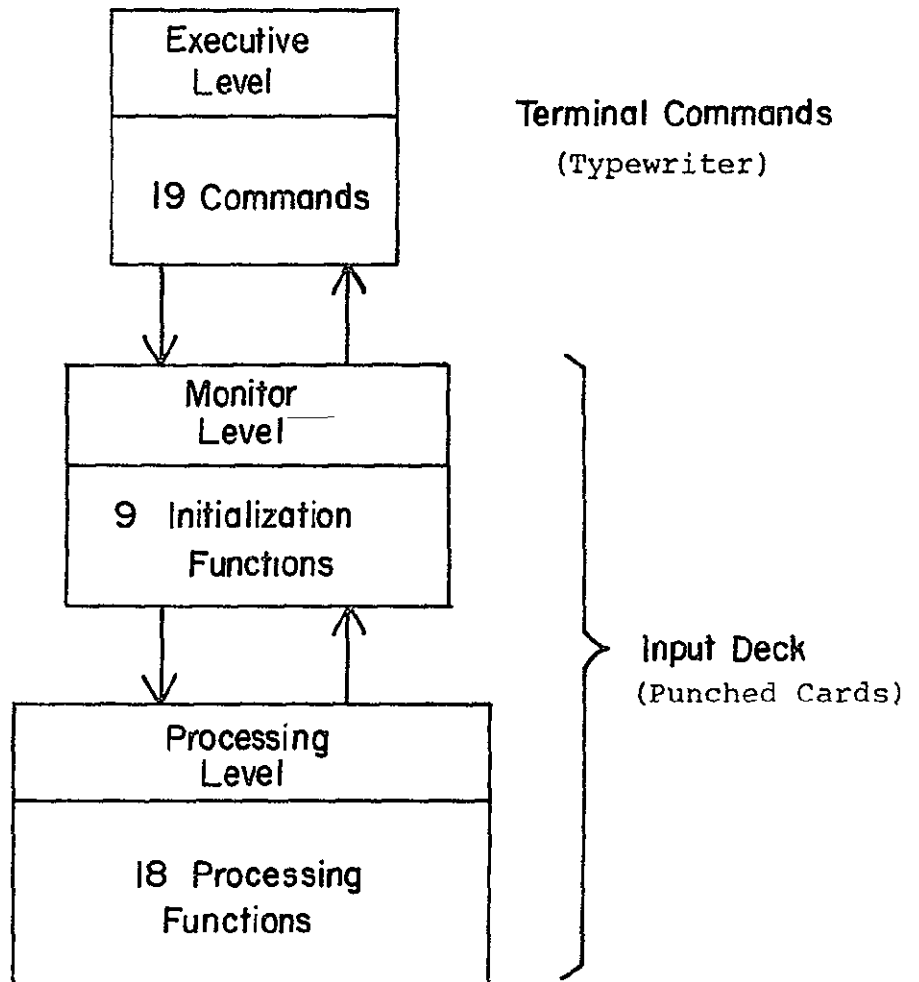
Manipulate

Analyze

a very high volume of data.

Communicated By:

Terminal Commands
(Typewriter)



The LARSYS Organization

Figure 1

TYPES OF INFORMATION ON MULTISPECTRAL IMAGE STORAGE TAPE

- Identification Information
- Calibration Information
- Data Addresses
- Data Values for each element of the ground scene

LARSYS can be used to obtain ID Information
from a Multispectral Image Storage Tape

LARSYS can produce Alphanumeric Pictorial Printouts

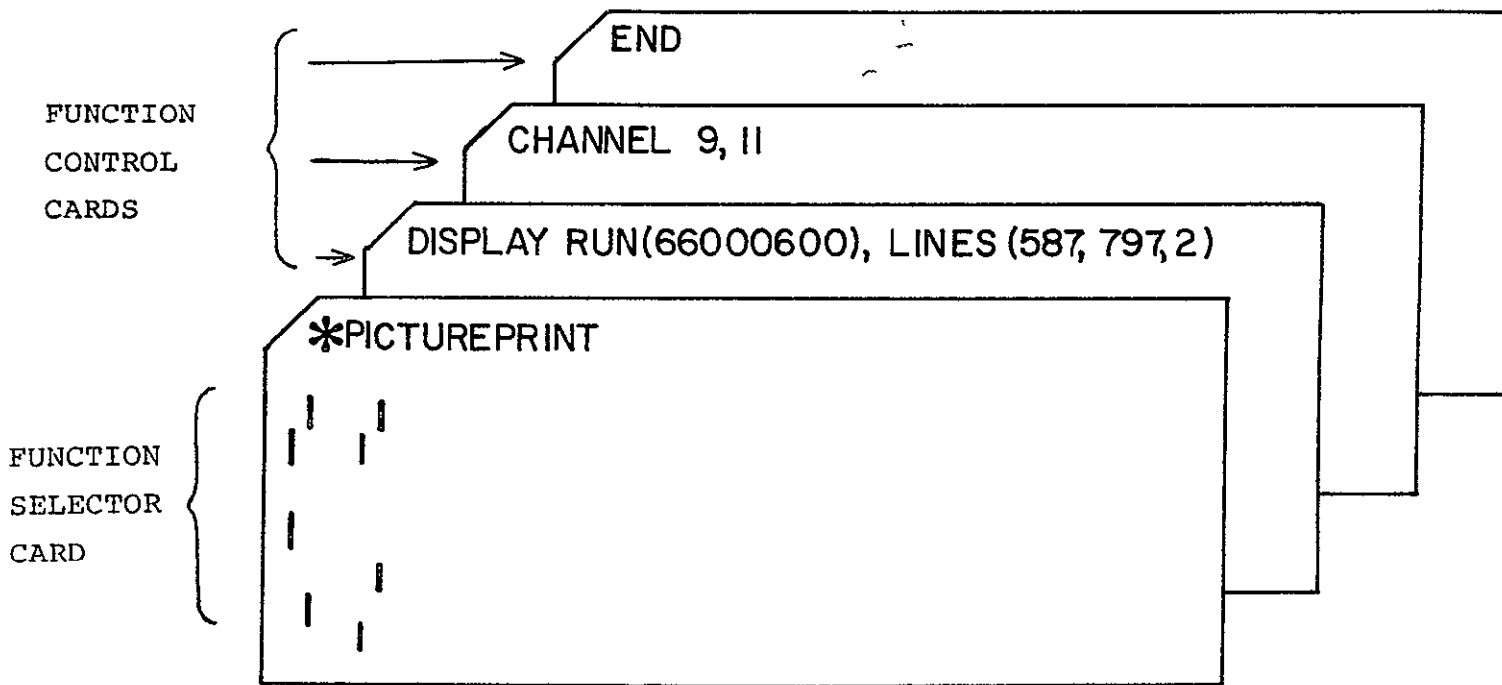


Figure 2

Control Cards used in running LARSYS Programs:

- Function Selector Card - (with * in column 1, tells which processing function is desired)
- Function Control Cards - (key word begins in column 1, card contains data addresses, computation options, type of output desired, etc.)
- Initialization Function Cards - (with hyphen in column 1, used for "housekeeping" functions such as putting identification

THE ANALYST USES REFERENCE DATA TO -

- Locate Training Fields (typical data samples) and Test Fields (to evaluate accuracy of classification results)
- Establish Field Boundaries (by comparing gray scale printout with aerial photograph)

Run Number	Field Number	Line Information			Column Information		Comment
		First Line	Last Line	Line Interval	First Column	Last Column	
66000600	7-24 731 737	1	129	177	1	ALFALFA	

SAMPLE OF FIELD DESCRIPTION CARD

Figure 3

***LINEGRAPH**

to produce graphs of
specified lines (or columns)
of data -- see Display 8

**Function Selector Card for LINEGRAPH
Function**

Figure 4

***CLUSTER**

to determine whether or not all
of the candidate training class data
is homogeneous or whether it should
be divided into a number of subclasses

**Function Selector Card for CLUSTER
Function**

Figure 5

LARSYS can be used to CLUSTER data sets.

The typical output includes:

- Maps of candidate training fields
- Statistics for candidate training classes
- Information about separability
of candidate training classes
- Histograms of data points associated
with a cluster (optional)

***STATISTICS**

to calculate the statistics
for data fields and data classes
in any set of channels

Function Selector Card for STATISTICS Function

Figure 6

LARSYS can provide means, standard deviations, and correlation matrices of data fields and classes.

The STATISTICS processing function produces the statistics deck needed for the SEPARABILITY and CLASSIFYPOINTS processing functions.

LARSYS can provide Histograms of data from individual fields of data and from classes (groups of data fields).

he STATISTICS processing function provides:

- Mean and standard deviation vectors
- Correlation matrices
- Statistics decks
- Histograms
- Coincident spectral plots

LARSYS assists in determining the degree of SEPARABILITY of classes.

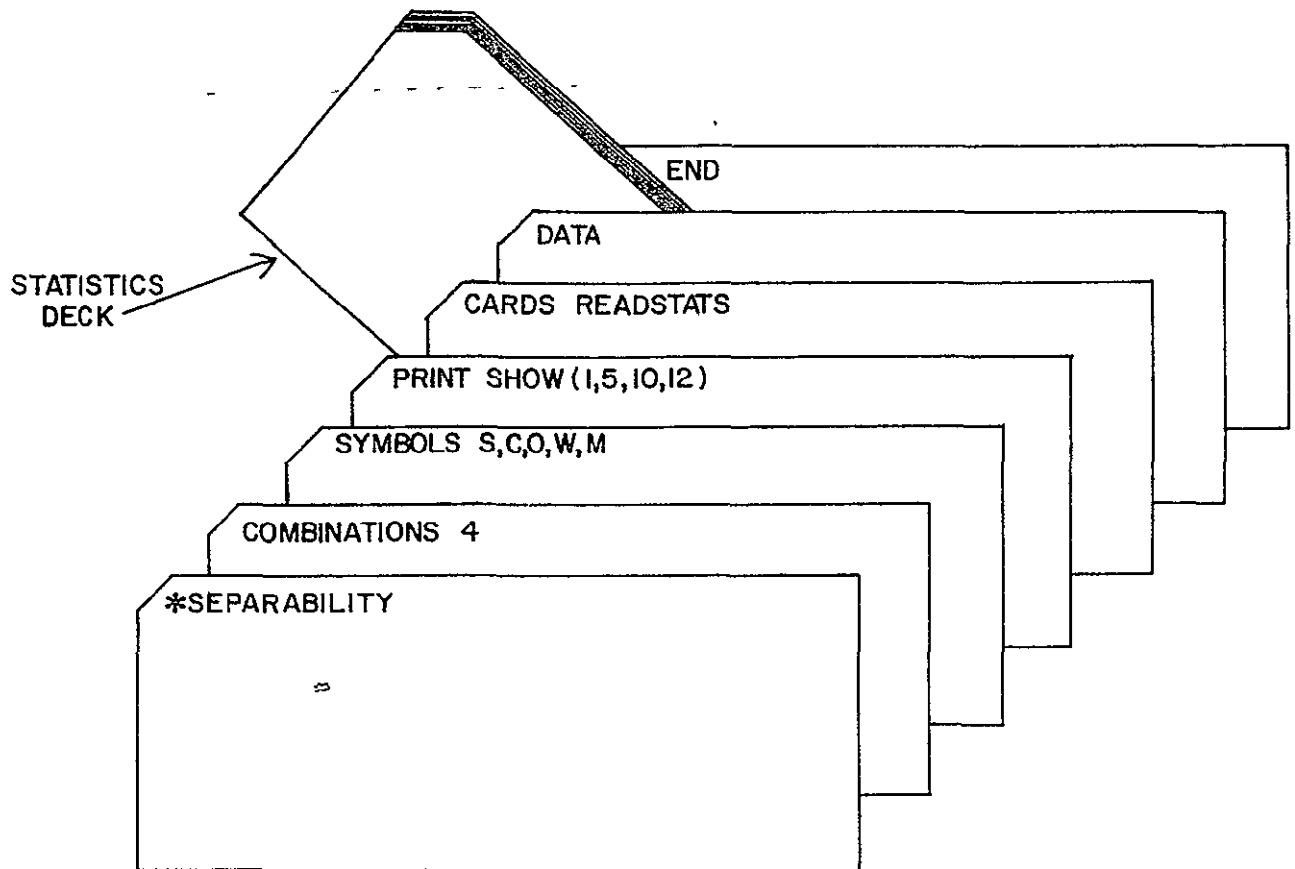


Figure 7

LARSYS helps select the best set of features.

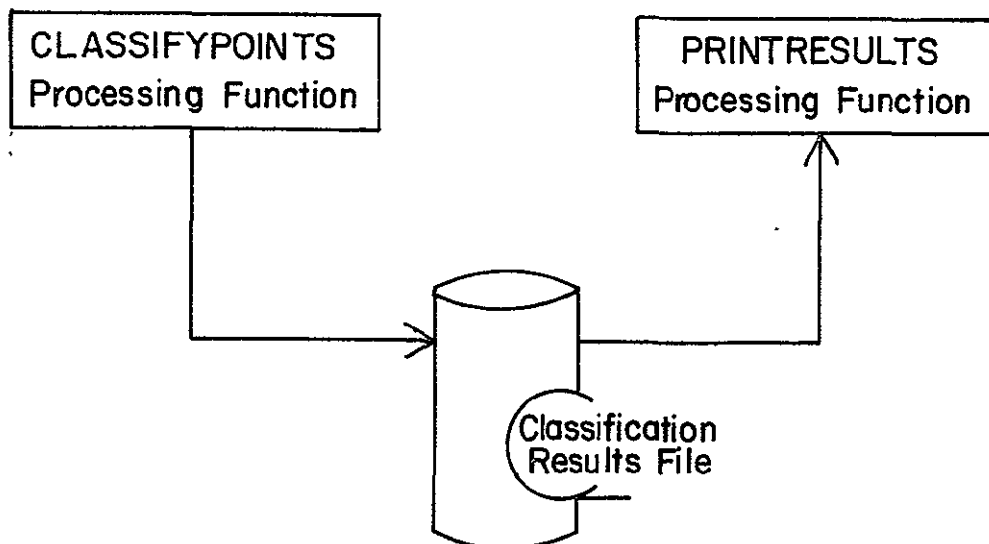


Figure 8

LARSYS can be used to classify data.

Results are displayed in map or tabular form.

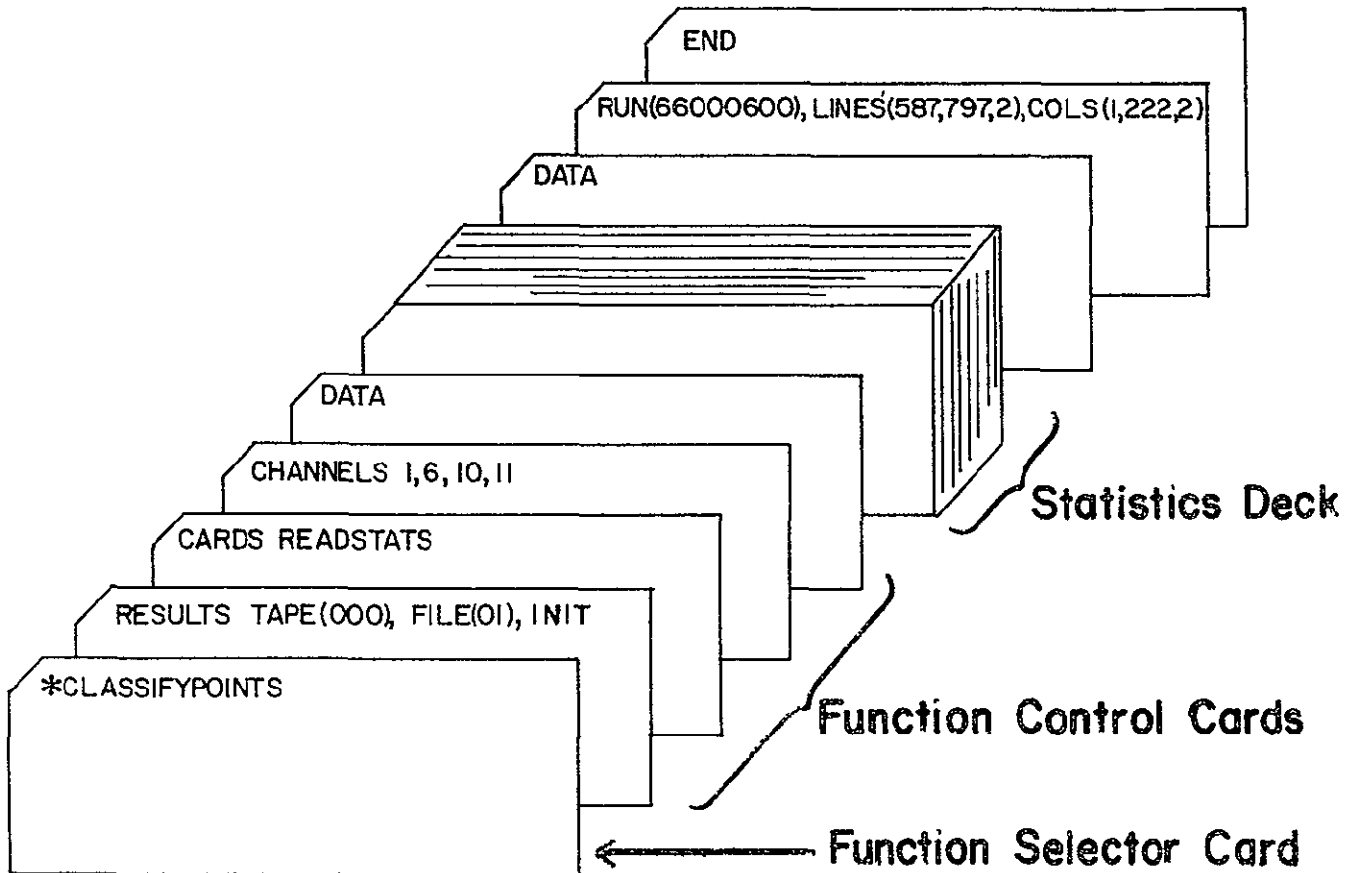


Figure 9

S U M M A R Y

LARSYS uses three types of control cards

- Initialization cards
- Function Selector cards
- Function Control cards

Multispectral Image Storage Tapes contain:

- Data Values
- Data Addresses
- Identification Information
- Calibration Information

LARSYS FunctionLARSYS Output Examples

IDPRINT

Identification Records

PICTUREPRINT

Grayscale Printouts

COLUMNGRAPH

Graphs of Columns

LINEGRAPH

Graphs of Lines

CLUSTER

{ Maps

{ Statistics

{ Separability Information

{ Histograms (optional)

STATISTICS

{ Histograms

{ Spectral Plots

{ Mean and Correlation
Matrices

{ Statistics Deck

SEPARABILITY

Statistical Distances
between class pairs

CLASSIFYPOINTS

Classification File

PRINTRESULTS

Classification Maps and
Performance Tables

Remember, this is an "overview." You are not expected to learn the details of the data processing procedure at this stage in your study.

Self-Check

A. The data source for the LARSYS processing functions is the Multispectral Image Storage Tape. It contains the following information:

- 1.
- 2.
- 3.
- 4.

B. What are the three types of control cards used in running LARSYS programs?

- 1.
- 2.
- 3.

C. Briefly describe the output of at least four of these Processing Functions.

*IDPRINT

*PICTUREPRINT

*COLUMNGRAPH, *LINEGRAPH

*CLUSTER

*STATISTICS

*SEPARABILITY

*CLASSIFYPOINTS

*PRINTRESULTS

(Check your answer with DISPLAY 25)

DEMONSTRATION OF LARSYS
ON THE DATA 100 REMOTE TERMINAL

Instructor's Notes

Preface to the Instructor

This instructor's guide is designed to help you give a "first time" demonstration of the Data 100 remote terminal. We have assumed that you are already familiar with the terminal and use the terminal in your daily activities. If you are a knowledgeable but infrequent user of the terminal, go through a "dry run" of the demonstration before presenting it to your students. For your convenience, the three decks used in the demonstration are listed in the Appendices to these notes.

Materials required: Student Notes
Control card decks (3)
Instructor's Notes

Time Estimate: The demonstration can be completed in one hour if the demonstrator doesn't talk too much. One and a half hours is typical.

Terminal sign-up and tape drive requirements: Insure your access to the terminal; reserve the terminal according to local procedures. Observe current LARS procedures for reserving tape drives.

Terminal Requirements: At the end of this unit you will be asked to provide the student with a copy of the terminal output. Therefore, if you are going to use a CRT a few extra commands will be necessary. After logging in, but before 'I LARSYS' (therefore you will be in CP mode):
Remote 009 to Flexlab1 (or other print site)
Spool 009 start copy MM (desired number of copies)
at the end of the demonstration (in CP mode):
Spool 009 close

LARSYS Demo
Instructor's Notes

STEPS IN CARRYING OUT THE DEMONSTRATION

I. Before you meet the student

1. Read the Instructor's Notes and Student Notes; locate the required control card decks.
2. Check to see that one of the Multispectral Image Storage Tapes assigned to your terminal site has a copy of run 66000600 on it. If it does, enter the tape number and file number below for easy reference:

Tape TTT = _____ File F = _____.

If it does not, see page 6 of "A Survey of the LARSYS Educational Package" at the front of these Instructor Notes.

3. Check the control card decks used with this demonstration. Make sure each deck includes a RUNTABLE initialization function to call into use your tape with run 66000600 on it. The deck setup should be:

```
-RUNTABLE  
DATA  
RUN(66000600), TAPE(TTT), FILE(F)  
END
```

where TTT and F are the tape and file number determined in step 2 above.

II. Preliminary Talk with Student

1. Talk to the student and determine what he knows about remote sensing, pattern recognition and LARSYS. See if he has any questions as a result of going through the LARSYS Software System - An Overview. (Unit 1,)
2. If the student is already somewhat familiar with the hardware, he may find this unit more interesting if you let him do as much of the demonstration himself as he can; as you tell him each step that needs to be demonstrated, he can carry out the demonstration for you.
3. If the student is unfamiliar with the hardware, assure him that he is not expected to run LARSYS unaided at the conclusion of this demonstration. The "Hands-on" experience in the next unit will teach him one-by-one the steps he needs to know.

LARSYS Demo
Instructor's Notes

III. The Demonstration

Step

1

Orientation to
physical setup

2

Use Data 100 off-line to
list control cards

3

Login, type name
initiate LARSYS

4

Read cards

5

Run STATISTICS job

6,7

Run CLASSIFYPOINTS job

Run PRINTRESULTS job; when requested type:
threshold $6*0.1$

8

Logout

Details of each step are on pages 4 and 5.

LARSYS Demo
Instructor's Notes

Step 1. Orient student to the physical setup.

- a. point out terminal documentation, LARSYS User's Manual, bulletin board, etc.
- b. describe sign-up procedures for terminal and tape drives, when applicable.
- c. point out and show controls, on/off switches on:

card reader/punch
printer
typewriter

Refer student to Figure 1 in Student's Notes.

- d. give student the name of the terminal coordinator and the person to see if a malfunction occurs.
For your own reference, fill in the blanks below:

Terminal coordinator at this site is _____.

Person to contact if the printer is out of paper or if a malfunction occurs is _____.

Step 2. Demonstrate use of the Data 100 off-line as a card lister.

- a. using the deck labeled "for listing" demonstrate:

card loading
home mode switch
printer operation

- b. give listing to student

Step 3. Demonstrate LARSYS Control Commands.

- a. login - (getting "on the air"); and enter name
- b. i larsys - (initiate LARSYS)
- c. news - (this is the system bulletin board)
- d. reference all - (mention that system has numerous user aids such as NEWS, REFERENCE, and LIST control commands. Student will need the LARSYS control card listing to do his future assignments. Point out how easily control card listings are obtained.)
- e. msg operator - I'm demonstrating system; if you get this message, please respond.

LARSYS Demo
Instructor's Notes

Step 4. Demonstrate how cards are read. Use deck labeled STATISTICS.

- a. point out need for ID card and what happens if you forget the ID card (cards won't read).
- b. point out that End-of-File must be lit before last card is read and how to recover if forgotten (load a blank card, hit EOF to light it and read blank card).
- c. point out computer response to a successful transfer of cards (typewriter message).

Step 5. Run the STATISTICS job read in above (type 'run larsys').

- a. While STATISTICS is running, read in all the remaining control cards (CLASSIFYPOINTS and PRINTRESULTS). Point out that you can read in cards for another job while running one job.
- b. Demonstrate receiving printer output.
- c. Demonstrate receiving punched output. Point out why you should use plenty of cards (if you run out of cards you can load more and START again but you may get some duplicate cards).

Step 6. Run the CLASSIFYPOINTS AND PRINTRESULTS jobs (type 'run larsys').

- a. Point out control cards have already been read in
- b. Point out progress messages; they let one know that the program is running.
- c. Point out how you can receive output from one job while running a second job.

Step 7. Correct (intentional) control card error in PRINTRESULTS deck.

- a. An error was deliberately made on a control card in the PRINTRESULTS program. When asked to type the correct card type:

threshold 6*0.1

- b. If you have not already done so, this is a good time to demonstrate how to recover from a typing error. (@ to delete a single character, ¢ to delete a whole line on a 2741, [on a CRT.)

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- c. You might also point out that by using the initialization card - TYPE in the card deck, you can enter control cards from the typewriter.

Step 8. Logout (type 'quit'). Obtain printer and punched output.

Points to emphasize during the demonstration:

LARSYS progress messages
LARSYS error messages and diagnostics
The three environments: Control Program (CP) Command Environment
 LARSYS Command Environment
 LARSYS Processor Environment
 (See Figure 2 in Student Notes)
How to send messages to the computer operator

At the end of the demonstration:

-If more than one student is witnessing the demonstration, supply each student with a copy (either original or Xerox) of the following:

- 1) listing of control cards used
- 2) the typewriter output
- 3) the printer output

Note: it would be reasonable for students to share the same output deck

-Be sure the student understands what he is to do with the output. Schedule a follow-up conference with him.

IV. Follow-up Conference

Go through the objectives with the student to:
- help him find answers to questions he has
- reinforce the material presented in the unit

Be certain that the student feels satisfied with the work he did with the output from the demonstration.

Make plans for doing the next unit, the "Hands-On Experience."

Appendix I: For Listing

DEMONSTRATION OF REMOTE TERMINAL

-COMMENT DEMONSTRATION OF THE DATA 100 REMOTE TERMINAL
-RUNTABLE

DATA
RUN(66000600),TAPE(TTT),FILE(F)
END
*STATISTICS
PRINT HIST(C),CORRE(C)
PUNCH CHARACTERS
CHANNELS 1,2,3,4,5,6,7,8,9,10,11,12
OPTION HIST(1,8,12)

Note: TTT and F should
be replaced by the
appropriate tape and
file numbers for your
location.

CLASS	SOYBEANS								
66000600	31-13	237	253	1	141	167	1	SOYBN	
66000600	36-7	307	327	1	59	81	1	SOYBN	
CLASS	CORN								
66000600	36-9	267	283	1	45	61	1	CORN	
66000600	36-8	319	341	1	21	31	1	CORN	
CLASS	OATS								
66000600	6-2	365	373	1	145	185	1	OATS	
66000600	1-11	421	455	1	63	83	1	OATS	
CLASS	WHEAT								
66000600	31-12	295	303	1	134	175	1	WHEAT	
66000600	6-14	471	495	1	177	201	1	WHEAT	
CLASS	RED CLVR								
66000600	6-10	439	447	1	139	183	1	RED CLVR	
66000600	1-1	539	565	1	175	195	1	RED CLVR	
CLASS	ALFALFA								
66000600	7-24	731	737	1	129	177	1	ALFALFA	

END
*
*
END OF FIRST DEMONSTRATION JOB.
*
*

-COMMENT DEMONSTRATION OF THE DATA 100 REMOTE TERMINAL
-RUNTABLE

DATA
RUN(66000600),TAPE(TTT),FILE(F)
END
*CLASSIFYPOINTS
RESULTS DISK
CHANNELS 1,6,10,11
CARDS READSTAT
DATA

*
*
*
STATISTICS DECK IN THIS LOCATION
*
*

DATA
RUN(66000600),LINES(271,711,2),COL(1,222,2)
END

(Continued)

ERROR IN THRESHOLD CARD. CORRECTION ENTERED FROM TYPEWRITER.

*****END OF DEMO LISTING DECK*****

Appendix II: Statistics

```

-RUNTABLE
DATA
RUN(66000600),TAPE(TTT),FILE(F)
END
-COMMENT DEMONSTRATION OF THE DATA 100 REMOTE TERMINAL
*STATISTICS
PRINT HIST(C),CORRE(C)
PUNCH CHARACTERS
CHANNELS 1,2,3,4,5,6,7,8,9,10,11,12
OPTIONS HIST(1,8,12)
DATA
CLASS SOYBEANS
66000600 31-13      237  253  1    141  167  1    SOYBN
66000600 36-7      307  327  1    59   81   1    SOYBN
CLASS CORN
66000600 36-9      267  283  1    45   61   1    CORN
66000600 36-8      319  341  1    21   31   1    CORN
CLASS OATS
66000600 6-2       365  373  1    145  185  1    OATS
66000600 1-11      421  455  1    63   83   1    OATS
CLASS WHEAT
66000600 31-12     295  303  1    134  175  1    WHEAT
66000600 6-14      471  495  1    177  201  1    WHEAT
CLASS RED CLVR
66000600 6-10      439  447  1    139  183  1    RED CLVR
66000600 1-1       539  565  1    175  195  1    RED CLVR
CLASS ALFALFA
66000600 7-24      731  737  1    129  177  1    ALFALFA
END

```

See note in Appendix I

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III-1

Appendix III: Classifypoints;Printresults

-COMMENT DEMONSTRATION OF THE DATA 100 REMOTE TERMINAL

-RUNTABLE

DATA

RUN(66000600),TAPE(TTT),FILE(F)

END

*CLASSIFYPOINTS

CARDS READSTATS

RESULTS DISK

CHANNELS 1,6,10,11

DATA

LARSYS VERSION 3 STATISTICS FILE

0

CLASS SOYBEANS

66000600 31-13

237 253 1

141 167 1

SOYBN

66000600 36-7

307 327 1

59 81 1

SOYBN

CLASS CORN

66000600 36-9

267 283 1

45 61 1

CORN

66000600 36-8

319 341 1

21 31 1

CORN

CLASS OATS

66000600 6-2

365 373 1

145 185 1

OATS

66000600 1-11

421 455 1

63 83 1

OATS

CLASS WHEAT

66000600 31-12

295 303 1

134 175 1

WHEAT

66000600 6-14

471 495 1

177 201 1

WHEAT

CLASS RED CLVR

66000600 6-10

439 447 1

139 183 1

RED CLVR

66000600 1-1

539 565 1

175 195 1

RED CLVR

CLASS ALFALFA

66000600 7-24

731 737 1

129 177 1

ALFALFA

CLASS 11 FIELD

CHAN 1 WAVELENGTH 0.40-

0.44 CCDE

1 CO

31.00 C1

41.05 C2

63.05

CHAN 2 WAVELENGTH 0.44-

0.46 CCDE

1 CO

31.00 C1

42.45 C2

67.30

CHAN 3 WAVELENGTH 0.46-

0.48 CCDE

1 CO

31.00 C1

41.85 C2

63.05

CHAN 4 WAVELENGTH 0.48-

0.50 CCDE

1 CO

31.00 C1

44.90 C2

72.05

CHAN 5 WAVELENGTH 0.50-

0.52 CCDE

1 CO

31.00 C1

59.10 C2

128.40

CHAN 6 WAVELENGTH 0.52-

0.55 CCDE

1 CO

31.00 C1

66.25 C2

139.35

CHAN 7 WAVELENGTH 0.55-

0.58 CCDE

1 CO

31.00 C1

59.45 C2

119.65

CHAN 8 WAVELENGTH 0.58-

0.62 CCDE

1 CO

31.00 C1

94.80 C2

229.40

CHAN 9 WAVELENGTH 0.62-

0.66 CCDE

1 CO

31.00 C1

96.90 C2

232.30

CHAN 10 WAVELENGTH 0.66-

0.72 CCDE

1 CO

31.00 C1

126.40 C2

248.70

CHAN 11 WAVELENGTH 0.72-

0.80 CCDE

1 CO

31.00 C1

100.50 C2

221.40

CHAN 12 WAVELENGTH 0.80-

1.00 CCDE

1 CO

31.00 C1

85.30 C2

214.50

NO. PTS. 942 542 1104 1003 972 343

MN 0.8442569E 02 0.7915286E 02

0.6117197E 02

0.6182059E 02

0.8450848E 02

02

MN 0.8660721E 02 0.6356262E 02

0.8212631E 02

0.6880997E 02

0.8021231E 02

02

MN 0.9208810E 02 0.7259978E 02

0.5952582E 02

0.5969740E 02

0.8178966E 02

02

MN 0.8367711E 02 0.7751291E 02

0.7562915E 02

0.6091144E 02

0.7201476E 02

02

MN 0.8610147E 02 0.6190221E 02

0.8375461E 02

0.5837680E 02

0.5916666E 02

0.8139764E 02

MN 0.7725090E 02 0.7427083E 02

0.8686322E 02

0.7283694E 02

0.8925452E 02

02

MN 0.8583694E 02 0.6454980E 02

0.8336230E 02

0.5720239E 02

0.5884346E 02

0.7857527E 02

MN 0.1059438E 03 0.6998404E 02

0.6205782E 02

0.9016550E 02

0.8157127E 02

0.9231604E 02

MN 0.7931406E 02 0.6205782E 02

0.6581256E 02

0.5415123E 02

0.5394341E 02

0.7136830E 02

MN 0.7802393E 02 0.6581256E 02

0.6882271E 02

0.6816151E 02

0.5501337E 02

0.7507304E 02

MN 0.7226749E 02 0.6882271E 02

0.5731172E 02

0.1046533E 03

0.5570845E 02

0.5583382E 02

MN 0.7828703E 02 0.5731172E 02

0.7186005E 02

0.6116034E 02

0.5524197E 02

0.7898833E 02

MN 0.1346913E 03 0.1046533E 03

0.5570845E 02

0.5583382E 02

0.7608162E 02

02

MN 0.7714577E 02 0.7186005E 02

0.6116034E 02

0.7060349E 02

0.5524197E 02

0.7898833E 02

MN 0.8580466E 02 0.6116034E 02

0.1100408E 03

0.7870337E 01

0.4498446E 01

0.4144777E 01

MN 0.1491545E 03 0.1100408E 03

0.6143146E 01

0.4311194E 01

0.2889546E 01

0.3726546E 01

CV 0.7787777E 01 0.6143146E 01

0.4292180E 01

0.5540514E 01

0.5869219E 01

0.1330864E 02

CV 0.3949139E 01 0.4292180E 01

0.8343015E 01

0.5028300E 01

0.5331158E 01

0.1049431E 02

CV 0.1451747E 01 0.8343015E 01

0.4912204E 01

0.4861828E 01

0.3458930E 01

0.3472991E 01

CV 0.7542513E 01 0.7656281E 01

0.6122395E 01

0.4813820E 01

0.6971671E 01

0.7015737E 01

CV 0.1084025E 02 0.4912204E 01

0.5086450E 01

0.9735908E 01

0.8813752E 01

0.5685491E 01

CV 0.6583952E 01 0.6122395E 01

0.5040768E 01

0.4284496E 01

0.6644647E 01

0.6402748E 01

CV 0.4731706E 01 0.5086450E 01

0.5086450E 01

0.3585127E 01

0.3577110E 01

0.6988630E 01

CV 0.1017850E 02 0.4773855E 01

0.6509813E 01

0.5146657E 01</

CV	0.1330350E	02	0.1241492E	02	0.7375128E	01	0.7193171E	01	0.1565623E	02	69
CV	0.5859072E	01	0.9555987E	01	0.5288501E	01	0.5703589E	01	0.1052970E	02	70
CV	0.9555303E	01	0.5853763E	01	0.5667624E	01	0.3504378E	01	0.3652427E	01	71
CV	0.6191963E	01	0.5307538E	01	0.4443285E	01	0.1000204E	02	0.1034029E	02	72
CV	0.5862646E	01	0.6229539E	01	0.1161317E	02	0.9547868E	01	0.6161450E	01	73
CV	0.1346111E	02	0.7413127E	01	0.8307984E	01	0.4370461E	01	0.5152451E	01	74
CV	0.8948066E	01	0.7655953E	01	0.5327738E	01	0.1039963E	02	0.1042837E	02	75
CV	0.6677602E	01	0.7506732E	01	0.4278730E	01	0.4616303E	01	0.8369099E	01	76
CV	0.7166706E	01	0.5252831E	01	0.9901972E	01	0.8838648E	01	0.1019941E	02	77
CV	0.4088397E	01	0.1119200E	01	0.1556329E	01	0.1521304E	00	0.2200019E	01	78
CV	0.2265061E	01	0.2617334E	00	0.2987299E	01	0.4962867E	01	0.2748640E	01	79
CV	0.3581422E	02	0.1244098E	01	0.8543015E	01	0.1405999E	00	0.1390823E	00	80
CV	0.4418222E	00	0.1341028E	01	0.2569418E	00	0.2056049E	01	0.2676115E	01	81
CV	0.2114671E	01	0.1245979E	02	0.1379734E	02					82
CV	0.9325022E	01	0.6059709E	01	0.7200381E	01	0.4475633E	01	0.3480809E	01	83
CV	0.3547820E	01	0.3382442E	01	0.3358265E	01	0.2105772E	01	0.2936838E	01	84
CV	0.9063329E	01	0.7023847E	01	0.5202701E	01	0.4494862E	01	0.1285987E	02	85
CV	0.9918551E	01	0.8320716E	01	0.4999842E	01	0.4726201E	01	0.1181648E	02	86
CV	0.1520458E	02	0.5644333E	01	0.4701364E	01	0.3293087E	01	0.2972650E	01	87
CV	0.6575366E	01	0.7584739E	01	0.5426346E	01	0.5290921E	01	0.6001719E	01	88
CV	0.4059744E	01	0.4247658E	01	0.8296504E	01	0.7450027E	01	0.5398932E	01	89
CV	0.1250983E	02	0.1183284E	01	0.3369673E	01	0.2137648E	01	0.3094288E	01	90
CV	0.3845490E	01	0.2089439E	01	0.3082472E	01	0.1026780E	02	0.1299968E	02	91
CV	0.2881681E	01	0.4245599E	01	0.3048126E	01	0.3555001E	01	0.5575939E	01	92
CV	0.4074175E	01	0.4314143E	01	0.1110465E	02	0.1163719E	02	0.1383271E	02	93
CV	0.9420268E	01	0.4778596E	01	0.3420093E	01	0.1517075E	01	0.7311563E	01	94
CV	0.1197996E	02	0.5201349E	01	0.3815485E	01	0.1140808E	02	0.7376445E	01	95
CV	0.4225975E	02	0.2920795E	01	0.1111212E	01	0.4481190E	00	0.1943185E	00	96
CV	0.1883900E	01	0.4274902E	01	0.1359993E	01	0.2926826E	01	0.5876502E	01	97
CV	0.4009802E	01	0.1487077E	02	0.1347695E	02					98
CV	0.4396299E	01	0.3504851E	01	0.5973797E	01	0.2952166E	01	0.3375486E	01	99
CV	0.3686541E	01	0.2641179E	01	0.3601293E	01	0.2634386E	01	0.3609206E	01	100
CV	0.5046841E	01	0.6558087E	01	0.4997225E	01	0.5238840E	01	0.1152801E	02	101
CV	0.4224591E	01	0.5740543E	01	0.4391463E	01	0.4854597E	01	0.8869050E	01	102
CV	0.9331409E	01	0.3036803E	01	0.3840244E	01	0.3233793E	01	0.3386306E	01	103
CV	0.2553127E	01	0.6117549E	01	0.5343958E	01	0.6021020E	01	0.8113420E	01	104
CV	0.6177404E	01	0.6894146E	01	0.1321707E	02	0.1250486E	02	0.9112176E	01	105
CV	0.3071309E	02	0.6016118E	01	0.8088963E	01	0.6152723E	01	0.6954782E	01	106
CV	0.1295546E	02	0.1244314E	02	0.9316233E	01	0.1970175E	02	0.2126711E	02	107
CV	0.6059793E	01	0.1050305E	02	0.8300241E	01	0.9256107E	01	0.1740881E	02	108
CV	0.1665013E	02	0.1265236E	02	0.2668616E	02	0.2738612E	02	0.3924631E	02	109
CV	0.4693321E	01	0.5768845E	01	0.4816509E	01	0.5247262E	01	0.1004111E	02	110
CV	0.1063918E	02	0.8282047E	01	0.1628545E	02	0.1613800E	02	0.2354033E	02	111
CV	0.2632877E	02	0.4055011E	01	0.5197605E	01	0.3951147E	01	0.4265041E	01	112
CV	0.8392366E	01	0.8403236E	01	0.5869133E	01	0.1300011E	02	0.1244751E	02	113
CV	0.1770001E	02	0.1295060E	02	0.1342990E	02					114
CV	0.5417562E	01	0.3579293E	01	0.4849257E	01	0.2640245E	01	0.2197982E	01	115
CV	0.2583695E	01	0.2520815E	01	0.2467094E	01	0.1646053E	01	0.2498340E	01	116
CV	0.5005395E	01	0.4700028E	01	0.3161542E	01	0.3286567E	01	0.8159942E	01	117
CV	0.4289777E	01	0.4190239E	01	0.2550777E	01	0.2850450E	01	0.5941545E	01	118
CV	0.6705372E	01	0.3019516E	01	0.2803848E	01	0.2113466E	01	0.2180375E	01	119
CV	0.3995263E	01	0.3789935E	01	0.3586555E	01	0.5159633E	01	0.5186831E	01	120
CV	0.3489450E	01	0.3899982E	01	0.7824073E	01	0.6356266E	01	0.4563396E	01	121
CV	0.1041364E	02	0.3557695E	01	0.3968614E	01	0.2466564E	01	0.3067698E	01	122
CV	0.5598570E	01	0.4410163E	01	0.3386146E	01	0.7301647E	01	0.7059553E	01	123
CV	0.4258505E	01	0.3878812E	01	0.2538890E	01	0.2619997E	01	0.5683676E	01	124
CV	0.5826591E	01	0.3785650E	01	0.5790455E	01	0.3853810E	01	0.7723804E	01	125
CV	0.8365055E	00	0.3128923E	01	0.1717435E	01	0.4925824E	01	0.5267256E	01	126
CV	0.3791051E	01	0.1267231E	01	0.1561539E	02	0.1749741E	02	0.1047159E	02	127
CV	0.1803907E	01	0.2110344E	01	0.1838565E	00	0.8218681E	00	0.1809546E	01	128
CV	0.1692974E	01	0.4062957E	01	0.3172528E	00	0.7263199E	01	0.9063329E	01	129
CV	0.8078904E	01	0.1010772E	03	0.7568707E	02					130
CV	0.2210453E	01	0.1152038E	01	0.3103166E	01	0.7765417E	00	0.9766252E	00	131
CV	0.1250425E	01	0.8634767E	00	0.1307085E	01	0.8783097E	00	0.1881660E	01	132
CV	0.1130895E	01	0.1040112E	01	0.1120360E	01	0.1209512E	01	0.3876357E	01	133
CV	0.2712478E	00	0.5474821E	00	0.2791417E	00	0.5200757E	00	0.9926005E	00	134
CV	0.2186878E	01	0.6169079E	00	0.7734672E	00	0.7574122E	00	0.8659062E	00	135
CV	0.7997374E	00	0.8238112E	00	0.1731523E	01	0.1362062E	01	0.2704584E	01	136
CV	0.1211549E	01	0.2027483E	01	0.3038310E	01	0.1472030E	01	0.1186571E	01	137
CV	0.5544081E	01	0.1145908E	01	0.2501799E	01	0.1298825E	01	0.2057674E	01	138
CV	0.2524048E	01	0.1170213E	01	0.1221318E	01	0.4429560E	01	0.5610864E	01	139
CV	0.5748043E	00	0.1089006E	01	0.9030228E	00	0.9074131E	00	0.1702708E	01	140
CV	0.1395375E	01	0.1020947E	01	0.2249748E	01	0.2017449E	01	0.3632790E	01	141
CV	0.2569374E	01	0.7191763E	01	0.2495754E	01	0.5149685E	01	0.4369375E	01	142
CV	0.1477639E	01	0.1150580E	01	0.9543817E	01	0.1178604E	02	0.6970232E	00	143
CV	0.6157545E	02	0.1874388E	01	0.3798365E	01	0.2432509E	01	0.2969805E	01	144
CV	0.3099833E	01	0.1180511E	01	0.5416517E	00	0.4334645E	01	0.5509905E	01	145
CV	0.5215419E	01	0.2269835E	02	0.2168253E	02					146

(Continued)

```

EOS                ***** LAST CARD OF STATISTICS DECK *****
DATA
RUN(66000600), LINES(271,711,2), COL(1,222,2)
END
*PRINTRESULTS
RESULTS DISK
PRINT OUTLINE(TRAIN,TEST), TRAIN(F,C), TEST(F,C,P)
SYMBOLS S,C,O,W,R,A
BHRESHOLD6*.01
DATA
TEST 1
66000600 12-3      705  797    2   69  111    2      SOYBN E PRT PR SOYBN
66000600 36-7      291  341    2   43   97    2      SOYBN VOLUNTR CORN
66000600 6-9       489  519    2  115  161    2      SOYBEANS
66000600 7-27      643  663    2  125  197    2      SOYBEANS
66000600 12-7      647  699    2   51   87    2      SOYBEANS
66000600 12-2      647  675    2   93  111    2      SOYBEANS
66000600 12-3      705  797    2   33   63    2      SOYBN W. PRT PLT ERL
TEST 2
66000600 36-9      261  287    2   39   65    2      CORN
66000600 36-8      307  349    2   19   35    2      CORN
66000600 6-11      401  421    2  111  199    2      CORN
66000600 12-9      589  643    2    3   43    2      CORN DIFF VARIETIES
TEST 3
66000600 31-11     327  335    2  109  197    2      OATS
66000600 6-2       365  377    2  131  183    2      OATS DITCH W END
66000600 1-11      413  467    2   45   93    2      OATS
66000600 7-1       583  605    2  121  193    2      OATS
TEST 4
66000600 31-12     285  317    2  109  199    2      WHEAT
66000600 6-1       347  353    2  107  205    2      WHEAT
66000600 6-1       385  393    2  109  203    2      WHEAT
66000600 6-14      459  509    2  167  211    2      WHT 2 VARIETIES
66000600 7-2       581  689    2  203  211    2      WHEAT
66000600 12-10     649  699    2    3   43    2      WHEAT 2 VAR LODGING
TEST 5
66000600 1-1       357  399    2   61   95    2      RED CL HAY
66000600 6-10      433  453    2  113  197    2      RED CL HAY
66000600 6-7       521  561    2  173  215    2      RED CL PASTURE
66000600 1-6       559  581    2   49  109    2      RED CL PASTURE
66000600 12-8      589  633    2   49  109    2      RED CL PASTURE
66000600 7-29      613  619    2  121  183    2      RD CL DIVERTED ACRES
66000600 7-28      629  637    2  123  191    2      RED CL HAY
END

```

**Student Notes
for**

**Demonstration of
LARSYS on a Data 100
Remote Terminal**

Developed by
Technology Transfer
The Laboratory for Applications of Remote Sensing
Purdue University West Lafayette, Indiana

1977

STAP INFORMATION FORM

1 Report No	2 Government Accession No	3 Recipient's Catalog No	
4 Title and Subtitle Demonstration of LARSYS on a Data 100 Terminal Student Notes		5 Report Date November 6, 1977	
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9 Performing Organization Name and Address Laboratory for Applications of Remote Sensing Purdue University West Lafayette, IN 47906		11 Contract or Grant No NAS9-14970	
		13 Type of Report and Period Covered Descriptive and Educational	
12 Sponsoring Agency Name and Address National Aeronautics and Space Administration Johnson Space Craft Center Houston, TX		14 Sponsoring Agency Code	
15 Supplementary Notes			
16 Abstract This unit provides the student with an introduction to the remote terminal hardware he will be using and introduces him to some aspects of the LARSYS software system. The demonstration requires an instructor to present the material and guide the student. The student's notes provide objectives and activities to reinforce the concepts presented. /			
17 Key Words (Suggested by Author(s)) LARSYS, Data 100, Educational Materials		18 Distribution Statement	
19 Security Classif (of this report) Unclassified	20 Security Classif (of this page) Unclassified	21 No of Pages	22 Price*

Prerequisites:

- a) List the four kinds of information (without regard to format) contained on a multispectral image storage tape.
- b) Name the three types of cards used in running LARSYS programs.
- c) Describe the output of at least four of the LARSYS processing functions discussed in the LARSYS Software System: An Overview

General Description: This demonstration introduces you to the computer hardware and provides an opportunity to increase your familiarity with the LARSYS system of programs. You will witness the running of several LARSYS jobs from a Data 100 terminal. During the demonstration you will see:

the Data 100 used off-line as a card lister
login procedure
user information obtained from LARSYS control commands
messages sent to the computer operator from the typewriter
card information transmitted from the Data 100 to the computer
line-printer output being received
card-punch output being received
logout procedure

The demonstration takes about 1 to 1½ hours. You will have ample opportunity to discuss the operations with your instructor during the demonstration. At the end of the demonstration you will be given a listing of the control cards used, the typewriter output and the printer and card-punch output. Examine these materials in some detail to reinforce the basic concepts presented. After you have completed this step, arrange a conference with your instructor.

This work was prepared under support of NASA Contract NAS 9-14970 by the Laboratory for Applications of Remote Sensing, Purdue University, West Lafayette, Indiana 47907.

T-1314/4

Objectives: Upon completion of the demonstration you should be able to:

1. Explain the local sign-up procedures.
2. Name the person who acts as terminal coordinator and the person to be contacted if the printer is out of paper or if another malfunction occurs.
3. While standing in the remote terminal area, point to:
 - the printer (and the printer control panel)
 - the card reader and control panel
 - the typewriter terminal
 - the LARSYS User's Manual
4. Describe in a few words:
 - the use of the Data 100 as an off-line card lister
 - the use of the typewriter for input and output
 - the use of the card reader for input
 - the use of the line printer for receiving output
5. Explain in general terms the use of LARSYS Control Commands to:
 - log in, log out
 - initialize LARSYS control system
 - start processing LARSYS control cards
 - obtain user assistance information (e.g., latest system news, listings of control commands).
6. Using the typewriter output, point out when the system was in CP command environment, LARSYS command environment, or LARSYS processor environment.
7. Using the typewriter output, name two kinds of user assistance information provided by LARSYS without being requested by the user.
8. With the listing of the control cards used in the demonstration:
 - correctly identify each control card as an Initialization Function Card, a Function Selector Card or a Function Control Card.
 - compare the listing against the REFERENCE ALL output to verify the completeness of the control card decks.
9. Locate typical information in the line-printer output.
10. Locate the ID card in the card-punch output.

Note: It is not intended that you be able to run LARSYS jobs unaided at the completion of this demonstration. The next unit in the LARSYS Educational Package, the "Hands-On" exercise, will help you learn the necessary steps for doing that.

During your preliminary talk with your instructor, fill in the following information for future reference.

1. Describe the local sign-up procedures:

2. Terminal coordinator at this site is _____.
3. Person to contact if the printer is out of paper or if a malfunction occurs is _____.

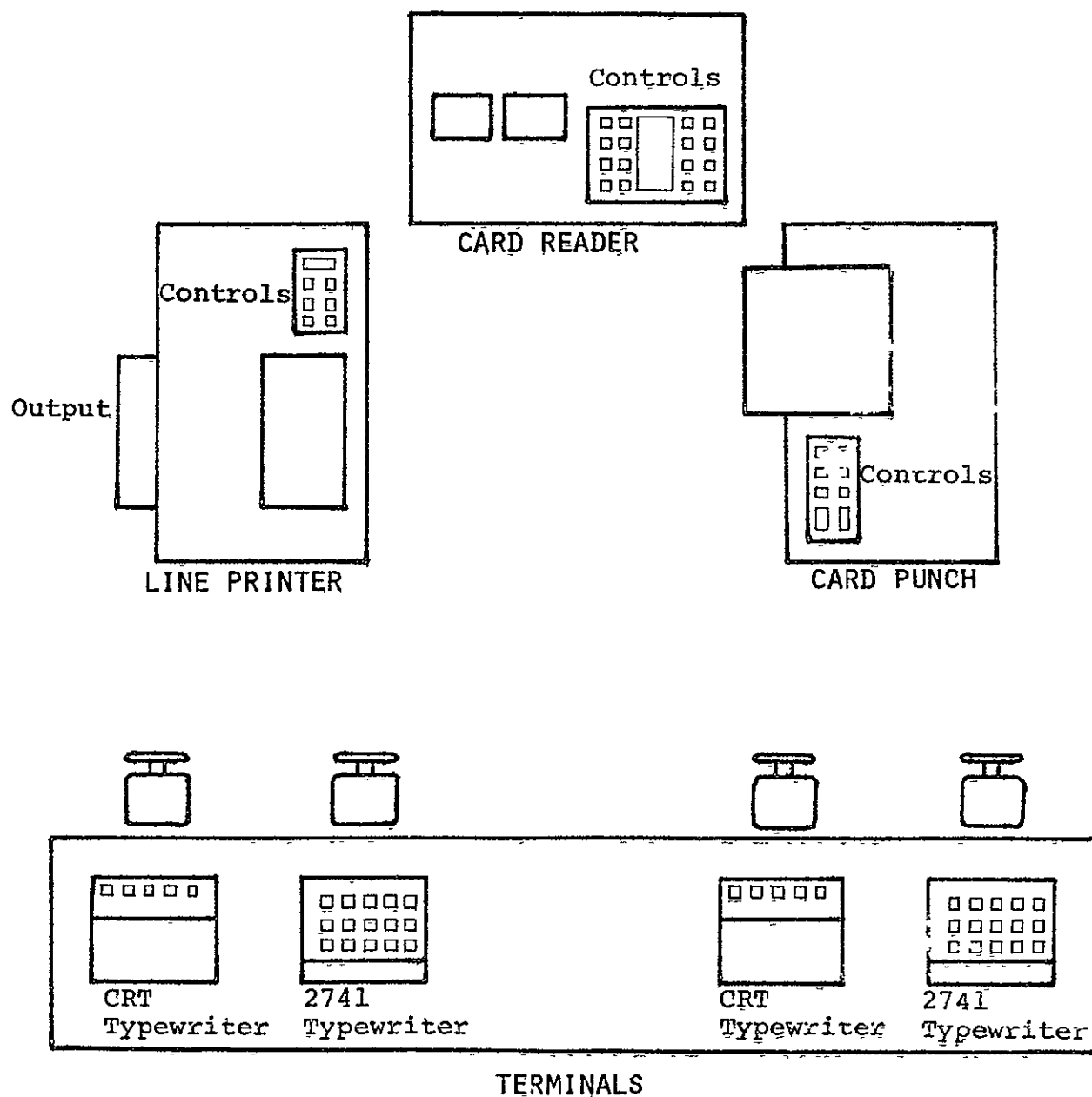


Figure 1

Typical Components of a Remote Terminal

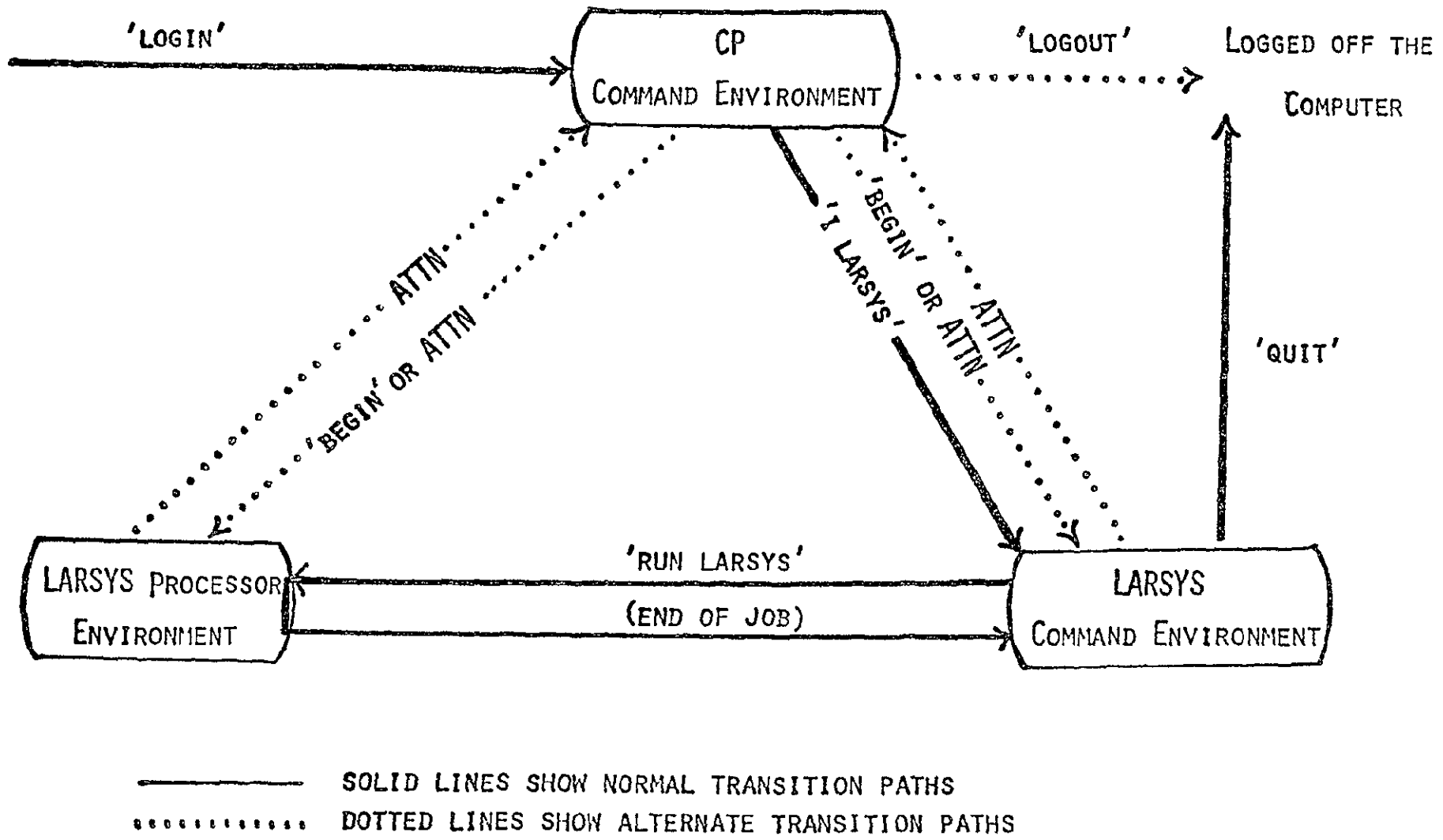


Figure 2. LARS Computer System Environment Diagram

After the demonstration

Go over the output that you have received:

1. - Using the typewriter output:

- a) mark on the output when the system was in CP (Control Program) command environment, LARSYS command environment, or LARSYS processor environment.

- b) locate each of these six steps

- Step 1: log in
 - Step 2: enter password
 - Step 3: enter your name
 - Step 4: initiate LARSYS
 - Step 5: run LARSYS
 - Step 6: log out

- c) point out an example of a progress message

- d) point out an example of an error message

2. Using the line-printer output:

- a) Identify each control card on the card listing as an Initialization Function Card, a Function Selector Card or a Function Control Card.

- b) Compare the listing for STATISTICS, CLASSIFYPOINTS, and PRINTRESULTS with the deck specifications in your REFERENCE ALL output. (You might find it useful to trim the REFERENCE ALL output, separate the pages, and staple them together for future use.)

- c) Locate in the output from STATISTICS where the training fields are identified, the mean and standard deviation vectors and correlation matrices, and the histograms for soybeans, for corn, for oats, for wheat, and for red clover.

- d) Locate in the output from CLASSIFYPOINTS and PRINTRESULTS the classification map with training and test fields outlined; locate performance percentages for training and for test fields.

3. Using the card-punch output:

- a) Identify the ID card, which appears in front of each piece of punched output to identify to whom it belongs. It is not considered part of the deck and must be removed before the deck is used as input to other processing functions.

When you have completed the above steps, make an appointment to meet with your instructor.

THE DATA 100 REMOTE TERMINAL:
A "HANDS-ON" EXPERIENCE

Instructor's Notes

Materials required: Student's Notes
Instructor's Notes
Audio tape, cassette tape recorder
Punched cards for listing
LARSYS User's Manual

Estimate of Instructor Time Required:

Briefing student on the preparation of his control cards:
5 min.

Checking control cards: 5 to 10 min.

Getting the student set up, explaining the use of the
tape recorder and general procedure to be followed:
10 min.

You will need to be available for help during the time the
student is at the terminal.

Terminal Sign-up and Tape Drive Requirements:

Have student sign up for two hours of terminal time. One
tape drive is needed; follow current policy for reserving
it.

Instructional Objectives:

The student will obtain a copy of the instructional objectives
for this unit when he lists the punched cards provided. For your
information, this listing is included on page 3 of these Instruc-
tor's Notes.

Before going to the terminal:

1. Check to see that one of the Multispectral Image Storage Tapes
assigned to your terminal site has a copy of run 66000600 on
it. If it does, enter the tape number and file number below
for easy reference:

Tape TTT = ____; FILE F = ____.

If it does not, see page 6 of A Survey of the LARSYS Educa-
tional Package.

2. Give student the notes which accompany this unit and check to
see that he meets the prerequisites.
3. See if your student has a user ID and password assigned to
him. If not, assist him in getting them assigned.
4. Tell him where he can find the LARSYS User's Manual.
5. Give student the computer tape number and file number used at
your remote site for run 66000600, and suggest he record them
on page 1 of his notes. Have him punch the control card decks
shown on pages 2-3 of the student's notes. (Show student how
to punch and duplicate cards on the key punch if he is not
familiar with it).
6. Check over the student's control card decks for errors.

At the terminal

1. Make sure the terminal is powered up.
2. Explain to the student the general procedure for using the audio tape and notes at the terminal and help him get set up. The student will be more comfortable doing the exercise if his tape recorder has earphones and batteries so that he can move around in the terminal area and not bother others working there.
3. Reassure student that malfunctions caused by the hardware may occur; he should not feel that when things go wrong it is necessarily his fault.
4. Start student on his way; answer questions as they arise. Watch long enough to see that he can load cards into the hopper, 9-edge down, using card weight. (See Figure 2 in Student's Notes)
5. If others are using the terminal, explain to them that your student is using the terminal for the first time and that, while it is nice to "help out," the student should be allowed to push all the buttons and retrieve all the output himself.

After the exercise

1. Talk with the student to determine how he did and his reaction to his "Hands-On" experience.
2. Make plans for working on the next unit in the sequence, the LARSYS Exercises.

***** LISTING DECK FOR DATA-100 HANDS-ON EXPERIENCE *****

OBJECTIVES FOR DATA-100 HANDS-ON EXPERIENCE

BY THE TIME YOU FINISH WITH THE TERMINAL TODAY YOU SHOULD BE ABLE TO
USE THE DATA-100 OFFLINE AS A CARD LISTER
LOGIN

USE THE LARSYS CONTROL COMMANDS TO

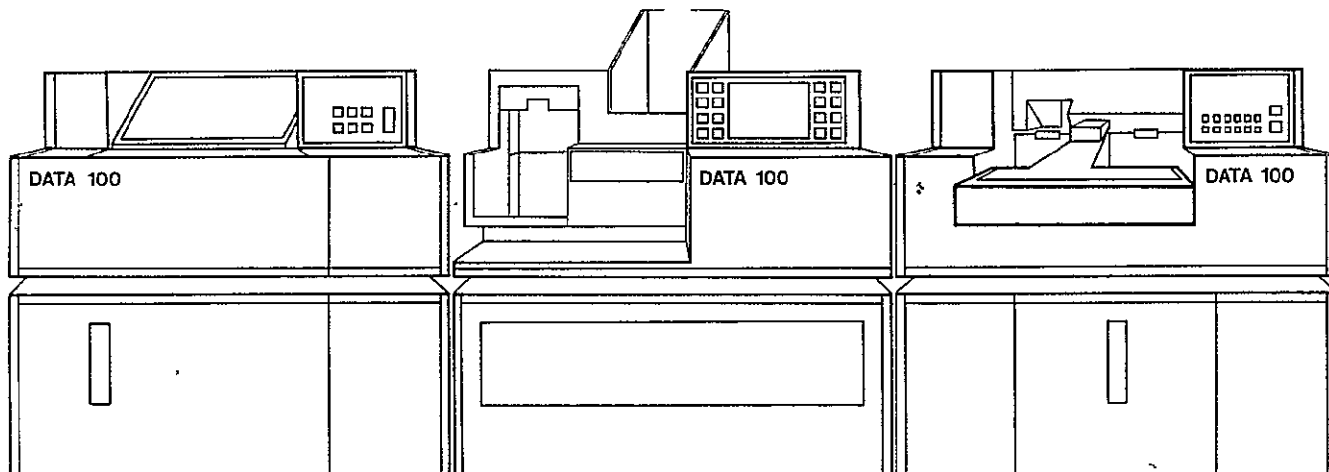
A) OBTAIN THE LATEST NEWS FILES FOR ANY OF THE FOLLOWING

SYSTEM
LARSYS
SCHEDULE

B) OBTAIN THE LATEST CONTROL CARD LISTINGS FOR THE LARSYS FUNCTIONS
RECEIVE PRINTER OUTPUT
TRANSMIT A DECK OF CARDS
RECEIVE PUNCHED OUTPUT
COMMUNICATE WITH THE COMPUTER OPERATOR OR A USER VIA
THE REMOTE TERMINAL NETWORK

*****END OF HANDS-ON LISTING DECK*****

Student Notes for The Data 100 Remote Terminal* ..A "Hands-on" Experience..



*Using either a
2741 typewriter,
or CRT typewriter

Developed by:
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Laboratory for Applications
of Remote Sensing
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West Lafayette, Indiana 47907

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4 Title and Subtitle Data 100 Remote Terminal - A Hands-On Experience Student Notes		5 Report Date November 7, 1977	6 Performing Organization Code
7 Author(s) James D. Russell		8 Performing Organization Report No 110777	10 Work Unit No
9 Performing Organization Name and Address Laboratory for Applications of Remote Sensing Purdue University West Lafayette, IN 47906		11 Contract or Grant No NAS9-14970	13 Type of Report and Period Covered Descriptive and Educational
12 Sponsoring Agency Name and Address National Aeronautics and Space Administration Johnson Space Craft Center Houston, TX		14 Sponsoring Agency Code	
15 Supplementary Notes			
16 Abstract In this unit the student is instructed in the use of the terminal by means of an audio-tape accompanied by these student notes. Details concerning interactive use of a CRT or typewriter console and a Data 100 remote terminal are presented.			
17 Key Words (Suggested by Author(s)) LARSYS, Data 100, Audio-tutorial		18 Distribution Statement	
19 Security Classif (of this report) Unclassified	20 Security Classif (of this page) Unclassified	21 No of Pages	22 Price*

THE DATA 100 REMOTE TERMINAL:
A "HANDS-ON" EXPERIENCE

Student's Notes

Prerequisites:

- a) Satisfactory completion of Units 1, 2 and 3 of the LARSYS Educational Package.
- b) Access to the terminal through the assignment of a user ID and a password.
- c) Basic ability to punch and duplicate control cards on a key punch.

Objectives: You will obtain a copy of the objectives of this minicourse early in your work at the terminal.

Estimated time: Including preparation time, time at the terminal and follow up, most students spend about 4½ hours on this unit.

Before going to the terminal:

- a) Find out from your instructor what tape and file numbers to use for data run 66000600:

Tape TTT = _____; File F = _____
- b) In order to survey the system capabilities from a "user" point of view, skim Section 2 of the LARSYS User's Manual, Volume I.
- c) Punch the 2 decks of cards described on pages 2 and 3 and let your instructor check them for accuracy. The annotations on the right briefly explain the purpose of the cards. Details may be found in the LARSYS User's Manual.
- d) Sign up for 2 hours of terminal time at a time when your instructor will be available; reserve one tape drive according to current policy.

This work was prepared under support of NASA Contract NAS 9-14970 by the Laboratory for Applications of Remote Sensing, Purdue University, West Lafayette, Indiana 47907

Control Cards for First LARSYS Run

<u>Punched on Card</u>	<u>Comment</u>
① ⑩ ID your ID	①, ⑩ indicate columns 1 and 10 on the ID card. All LARSYS control cards begin in column 1.
-COMMENT DEMONSTRATION OF STATISTICS FUNCTION	This comment will appear at the top of your printer output.
-RUNTABLE DATA RUN(66000600), TAPE(TTT), FILE(F) END	These four cards create a special runtable which allows you to access the Multispectral Image Storage Tape assigned to your remote terminal site. See your instructor for tape and file numbers.
*STATISTICS	Tells LARSYS monitor you will run a job using the STATISTICS processing function.
PRINT HIST(C), CORRE(C)	Indicates that histograms and correlation matrices are desired for each class (C).
PUNCH CHARACTERS	Requests punched statistics file in character (not binary) format.
CHANNELS 1,2,3,4,5,6,7,8,9,10,11,12	Designates channels for which statistics are to be computed.
OPTIONS HIST(1,8,12)	Designates channels for which histograms are desired.
DATA	Signals that a data deck will follow next.
CLASS SOYBEANS	Indicates that cards following define soybean training fields.
① ⑪ ⑫ ⑮ ⑰ ⑲ ⑳ ㉑ ㉒ 66000600 31-13 237 253 1 141 167 1 SOYBN 66000600 36-7 307 327 1 59 81 1 SOYBN	
Punch these field description cards using the columns indicated. The following cards define the corn training fields; use the same columns.	
CLASS CORN 66000600 36-9 267 283 1 45 61 1 CORN 66000600 36-8 319 341 1 21 31 1 CORN	
END	Signifies end of function

Put a rubber band around the above deck of cards. They will be used in your first LARSYS job.

Control Cards for Second LARSYS Run

①

⑩

ID

your ID

-COMMENT DEMONSTRATION OF IDPRINT AND PICTUREPRINT FUNCTIONS

-RUNTABLE

DATA

RUN(66000600), TAPE(TTT), FILE(F) Use same tape and file number
you used before.

END

*IDPRINT

PRINT RUN(66000600)

END

}

Requests ID record of run 66000600.

*PICTUREPRINT

Requests gray scale map of area
defined on next card.

DISPLAY RUN(66000600), LINE(1,199,2), COL(1,222,2).

HISTOGRAM COMPUTE

Requests that histograms be
computed.

PUNCH HISTOGRAM

Punch histogram file in binary
format.

BLOCK RUN(66000600), LINE(1,1001,2), COL(1,222,4)

Gives area for histogram.

CHANNEL 6

Signifies channel desired.

END

Signifies end of function.

Put a rubber band around this deck. It will be used to run your
second set of LARSYS functions.

Materials required at the terminal:

- 2 decks of punched cards you prepared as specified on pages 2 and 3.
- 1 deck of punched cards supplied in the unit box.
- 1 audio tape "The Data 100 Remote Terminal - a 'Hands-On' Experience."
- 1 cassette tape recorder, preferably equipped with earphones and batteries.
- 1 experienced instructor to start you off and to be available if you run into difficulties
- 1 copy of LARSYS User's Manual - there should be one near the terminal.

Outline of Terminal Session

- Part 1. Introduction and Orientation to terminal layout
- Part 2. Using the Data 100 off-line as a card lister
- Part 3. "Login," enter name, and initiate the LARSYS system.
- Part 4. Run sample LARSYS jobs

Normally students can complete their work at the terminal in an hour, although that time may be doubled during the "heavy use" hours.

Begin the exercise by having your instructor explain the use of the tape recorder and general procedure to be followed during the unit. He should let you know where he can be reached while you are at the terminal, and you should not hesitate to ask him for help.

Part 1 - Introduction and Orientation to hardware layout

Stand in the remote terminal area and start the tape recorder.

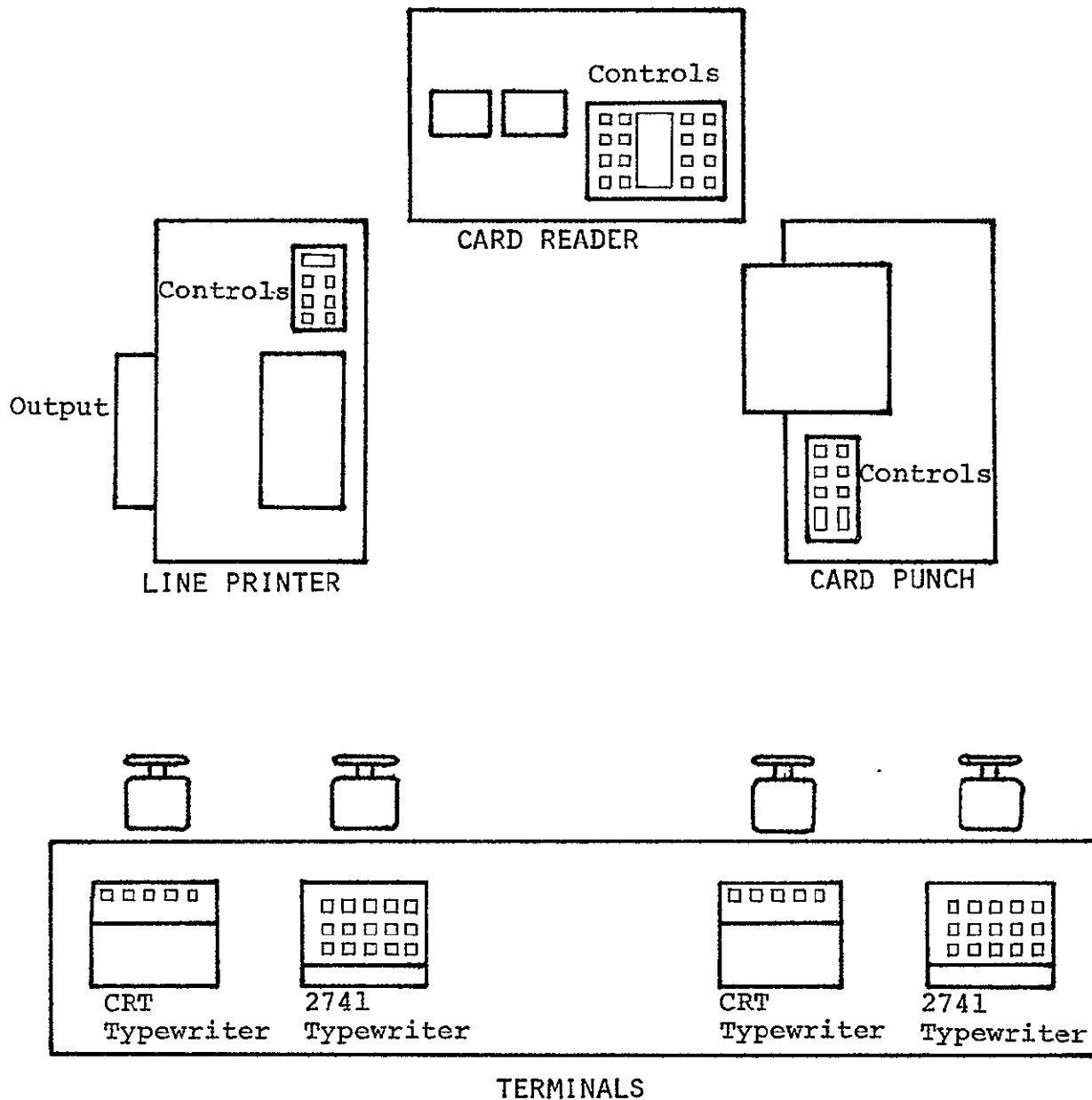


Figure 1

Typical Components of a Remote Terminal

Part 2 - Using the Data 100 off-line to list cards

Stand in front of the card reader and load the "listing deck" in the hopper (See Figure 2)

Heed the warning on tape: if you get a card reader malfunction, try the procedure given in Appendix A. If that doesn't work, get your instructor to help.

Go to the printer controls and push the STOP, PAGE EJECT, and START buttons to be sure your listing will start a new page.

To the right of the card reader, check to see if HOME MODE button is lit (if not push it once to light it). END OF FILE and TRSP (transparent) lights must also be lit. Then press the STOP, ABORT, and START buttons, in that order. Your cards should be read and printed on the printer.

When all cards have been read, remove the cards from the reader, move to the printer and press STOP on the printer control panel. Then press the PAGE EJECT button 4 times, go to the back of the printer and remove your output. Return to front of printer and push START button. Read over the objectives for this unit which were just printed.

After cards have been read, listed and printout removed from reader, push HOME MODE button again, so it will go off.

The above steps are summarized in Appendix B, page 17.
--

REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

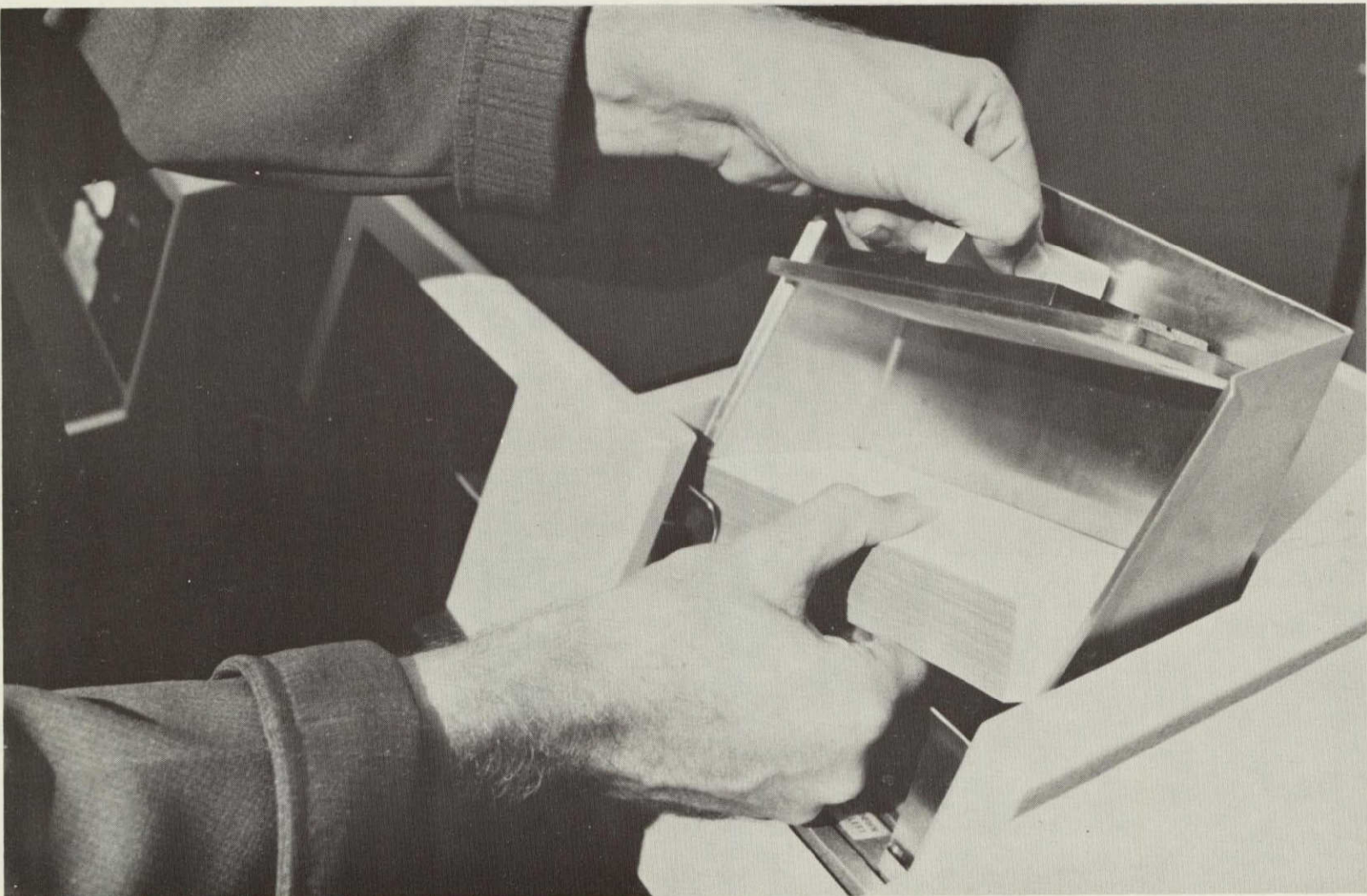


Figure 2

Loading Cards into the Card Hopper

Part 3 - "LOGIN" and initiate the LARSYS System

Sit in front of the keyboard; locate these notes so they will be handy

If you make a typing error, see Appendix A.

login *userid*
ENTER PASSWORD:

ENTER NAME: *your name*
LOGMSG - 13:47:40 EST WEDNESDAY 09/28/77
* FOR MORE INFORMATION, TYPE IN (CP COMMAND) 'QUERY LOGMSG'.
* NEXT SCHEDULED SHUTDOWN IS 0800 SAT, SYSTEM UP 1500 SUN.
LOGON AT 16:11:45 EST WEDNESDAY 09/28/77

press ATTN or BREAK (BRK)
you type (and press RETURN /CR)
computer responds
type password (and press RETURN /CR)
type your name (and press RETURN /CR)
type 'i larsys' (and press RETURN /CR)
i larsys
LARSYS (Version 3.1) READY;
type 'news' (and press RETURN /CR)
T=1.18/2.05 16:12:38
news

REVISED 09/11/77

A NUMBER OF MINOR ERRORS WERE FIXED IN LARSYS. THESE INCLUDE PROBLEMS WITH -COMMENT, A FIX IN IDPRINT TO VERIFY THAT THE CORRECT TAPE IS MOUNTED, AND CHECKING FOR CORRECT COLUMNS IN LINEGRAPH. USE THE COMMAND 'NEWS LARSYS' FOR MORE DETAILS.

T=0.87/1.08 16:13:15

Note: response to the NEWS command changes frequently. You will get a different message than the one shown here.

(continued on next page)

Part 4 - Sample LARSYS jobs

Review the objectives of this unit.
Locate your first LARSYS control deck (*STATISTICS) and
move to the card reader.
Load cards into hopper.
Press STOP and ABORT buttons.
If END OF FILE is not lit, press END OF FILE button.
Press START.
Cards should read in.

After cards have been read, remove cards from the reader.

(RETURN/CR)

PUN FILE 0548 FROM RSCS COPY 01 NOHOLD

T=0.72/0.89 16:17:03

run larsys

type 'run larsys' (RETURN/CR)

EXECUTION BEGINS...

I0102 COMMENT - DEMONSTRATION OF STATISTICS FUNCTION

I0198 STATISTICS FUNCTION REQUESTED (STASUP)
I0034 ALL CONTROL AND DATA CARDS HAVE BEEN READ (STAIN)
I0200 TRAINING FIELDS NOW BEING PROCESSED. (STAIN)
I0201 STATISTICS BEING CALCULATED FOR CLASS SOYBEANS (LEARN)
I0002 TAPE 0445 HAS BEEN REQUESTED ON UNIT 0181 (MOUNT)
TAPE 181 ATTACHED
I0003 TAPE READY... EXECUTION CONTINUING (MOUNT)
I0035 SEARCHING FOR RUN 66000600 (GADRUN)
I0036 DESIRED RUN FOUND...66000600 (GADRUN)

press ATTN or BREAK(BRK)

CP

*type on one line - - -
'msg operator I am learning
to use the terminal. Please
respond when you get this
message.' (RETURN/CR)*

msg operator I am learning to use the terminal. Please respond
when you get this message.

type 'sleep' (RETURN/CR)

sleep

(operator will respond)

CP ← *press ATTN or BREAK(BRK)*

begin ← *type "begin" (RETURN/CR)*

```
I0201  STATISTICS BEING CALCULATED FOR CLASS CORN      (LEARN)
I0209  COINCIDENT SPECTRAL PLOT(S) PRINTED,          (MULSPC)
I0208  STATISTICS BEING PUNCHED                      (PCHSTA)
I0199  STATISTICS FUNCTION COMPLETED                (STASUP)
I0103  CPU TIME USED WAS    20.659 SECONDS.          (LARSMN)
PRT FILE 0553  TO  RSCS      COPY 01 NOHOLD
PUN FILE 0556  To   RSCS      COPY 01 NOHOLD
```

```
I0004  END OF INPUT DECK - RUN COMPLETED  (LARSMN)
I0050  TOTAL CPU TIME FOR THIS RUN WAS    21.003 SECONDS.  (LARSMN)
TAPE 181 DETACHED
T=18.66/22.85 16:20:41
```

You should now receive output at the printer. If it did not begin printing automatically, move to the printer and press the START button.

When printer is finished:

- press the STOP button
- press PAGE EJECT four times

Remove printer output, and press START on the printer control panel.

if START light is on and cards are in the Card Punch, you should receive your punched output automatically.

- if START button is not lit, push it
- if there are less than a couple inches of cards in punch, load several inches of additional cards

Remove punched cards

There is one more function to be run

run larsys ← *type "run larsys" (RETURN/CR)*

Secure your printer output.

Discussion - why the error occurred.

For E-messages (error messages) and I-messages
(information messages) refer to Appendix III
in Volume 3 of LARSYS User's Manual

To correct the error -

Locate your second deck (*IDPRINT and *PICTUREPRINT),
load into the card reader, and read in.

(RETURN/CR)

PUN FILE 0562 FROM RSCS COPY 01 NOHOLD

T=0.71/0.91 16:24:09 1

type 'run larsys' (RETURN/CR)

run larsys

EXECUTION BEGINS...

I0102 COMMENT - DEMONSTRATION OF IDPRINT AND PICTUREPRINT
FUNCTIONS (LARSMN)

I0065 IDPRINT FUNCTION HAS BEEN REQUESTED. (RUNSUP)

I0002 TAPE 0445 HAS BEEN REQUESTED ON UNIT 0181 (MOUNT)

TAPE 181 ATTACHED

I0003 TAPE READY...EXECUTION CONTINUING (MOUNT)

I0114 IDPRINT FUNCTION COMPLETED. (RUNSUP)

I0103 CPU TIME USED WAS 0.665 SECONDS. (LARSMN)

I0092 PICTUREPRINT FUNCTION REQUESTED (PICSUP)

I0237 ALL CONTROL CARDS FOR PICTUREPRINT HAVE BEEN READ (PICRDR)

I0082 100 LINES HISTOGRAMMED. (HISTD)

I0082 200 LINES HISTOGRAMMED. (HISTD)

I0082 300 LINES HISTOGRAMMED. (HISTD)

I0082 400 LINES HISTOGRAMMED. (HISTD)

I0091 END OF FILE REACHED ON MULTISPECTRAL IMAGE STORAGE TAPE. (LINERR)

I0084 HISTOGRAM(S) READY TO BE PUNCHED. (HISTD)

press ATTN or BREAK(BRK)

CP

*type 'msg yourid this is a
test message' (RETURN/CR)*

msg yourid this is a test message

FROM YOURID: THIS IS A TEST MESSAGE

type 'begin' (RETURN/CR)

begin←

```
I0099      100 LINES DISPLAYED FOR CHANNEL 6      (PIC1)
I0093      PICTUREPRINT FUNCTION COMPLETED      (PICSUP)
I0103      CPU TIME USED WAS 15.491 SECONDS.      (LARSMN)
PRT FILE 0564 TO RSCS COPY 01 NOHOLD
PUN FILE 0566 TO RSCS COPY 01 OHOLD
```

```
I0004 END OF INPUT DECK - RUN COMPLETED      (LARSMN)
I0050 TOTAL CPU TIME FOR THIS RUN WAS 16.463 SECONDS.      (LARSMN)
TAPE 181 DETACHED
T=13.61/18.33 16:29:10
```

type 'quit' (RETURN/CR)

quit←

```
16:29:27
CONNECT = 00:51:40 VIRTCPU = 000:32.26 TOTCPU = 000:46.74
LOGOUT AT 09.18.23 ON 12/05/74
```

vm/370 online ljh359 qsyosu

Obtain your printer output. See Appendix D if you need more detailed instructions.

Obtain your punched output. See Appendix D if you need more detailed instructions.

After the session at the terminal

1. Save these notes, and any printed or punched output for future use.
2. There are some features of the punched output decks you received that you should be familiar with:

First take the ID card off the front of each deck; it is not considered part of the deck. Duplicate it on the keypunch and check that your ID and name are on the card.

Next duplicate (using the key punch) the first and last card of each deck; now you will be able to "read" the punches. Write down what you find there.

Statistics Deck:

1st card _____

last card _____

Histogram Deck:

1st card _____

last card _____

- The two punched decks serve as examples of two types of deck format: character and binary. The first card in the Statistics deck identifies the format chosen by the user.
 - If column 44 contains a 0, the deck is a character deck.
 - If column 44 contains a 1, the deck is a binary deck.

This Statistics Deck is in _____ format.

The Histogram Decks are in binary format.

- ° The decks are numbered so that they can be reassembled if they are dropped.
 - The cards in the Statistics Deck have sequence numbers in columns 73 - 80 beginning with number 1.
 - The cards in the Histogram Deck are also numbered in ascending order, but they are not numbered consecutively.
3. After examining your printed and punched output, let your instructor know how you did on the unit and make plans for doing the LARSYS Exercises, Unit 5.

Appendix A: MALFUNCTION RECOVERY PROCEDURES

Cards Won't Read

<u>Condition</u>	<u>Probable Cause</u>	<u>Recovery</u>
A few cards read, then reader stops reading cards but continues to run (red INCLPT light comes on)	No ID Card	Remove all cards from reader. Press STOP and ABORT buttons. Read in one blank card. Press STOP and ABORT buttons. Reassemble your deck with your ID card on the front, reload the hopper, and try again.
Cards start reading and the "equipment check" (red light on top row) may come on	Cards bent, torn or uneven	Remove all cards from the reader. Put a blank card in hopper, make sure END OF FILE button is lit, read in blank card Go to typewriter, push RETURN (you should receive a message that cards have been transferred) Type 'clear reader' RETURN (these steps remove the partial deck that had already been read in) Check original deck for bent or torn cards and make new cards where needed Read deck in again. If you still can't get the cards to read after three attempts, check with your instructor.
First card read and 'no response' (right side, in middle) light is on	Normal condition	Wait 20 seconds - cards should continue reading

The Data-100 may pause from time to time while reading cards - this is normal - reading should resume within 10-20 seconds.

~ In all other cases see your instructor.

System Error Messages

?CP-system is in the CP command environment; you have just typed an invalid CP command.

El16-'COMMAND' IS NOT A VALID CONTROL COMMAND (EXCOMD)
System is in the LARSYS command environment; you have typed an invalid command.

All system error messages are identified in Appendix III (Vol. 3) of the LARSYS User's Manual.

Typing Errors

One (or up to several) letter(s) in error.
type an @ symbol for each letter in error,
then continue with your message.

Example:

run larty@sys would be interpreted as:

run larsys - -

Deletion of a whole line

on the 2741 typewriter type ¢, then the desired line.

on the CRT typewriter type [, then the desired line.

Example:

news larys¢ reference larsys would be interpreted as:

reference larsys

END OF FILE not lit when Transmitting Cards

If the END OF FILE button was not lit when cards were transmitted, you can recover in the following way:

put a blank card in the hopper
press END OF FILE button to turn it on and then push START
on the reader

To verify successful transmission, press RETURN on typewriter

Appendix B: USING DATA 100 AS A CARD LISTER

load cards
on printer push STOP, PAGE EJECT and START buttons
on reader following lights must be on: HOME MODE, END OF FILE
and TRSP (if any are not, push them)
on reader push STOP, ABORT, HOME MODE (if it is not on) and
START buttons
.
.
cards listed
.
.
remove cards from reader
on printer push STOP and PAGE EJECT 4 times
remove printed output
on printer push START
on reader push HOME MODE to turn it off

Appendix C: SENDING MESSAGES

Send message to operator

press ATTN or BREAK
type "msg cp" and your message
press RETURN/CR

Send message to another user

press ATTN or BREAK
type: "msg"
id of user being addressed } all on one line
the message you are sending }
press RETURN/CR

Note: messages sent as described above are limited to
one line on the typewriter. To send longer messages,
see LARSYS User's Manual.

Appendix D: TRANSMITTING DATA TO AND RECEIVING DATA FROM THE
MAIN COMPUTER

To transmit cards

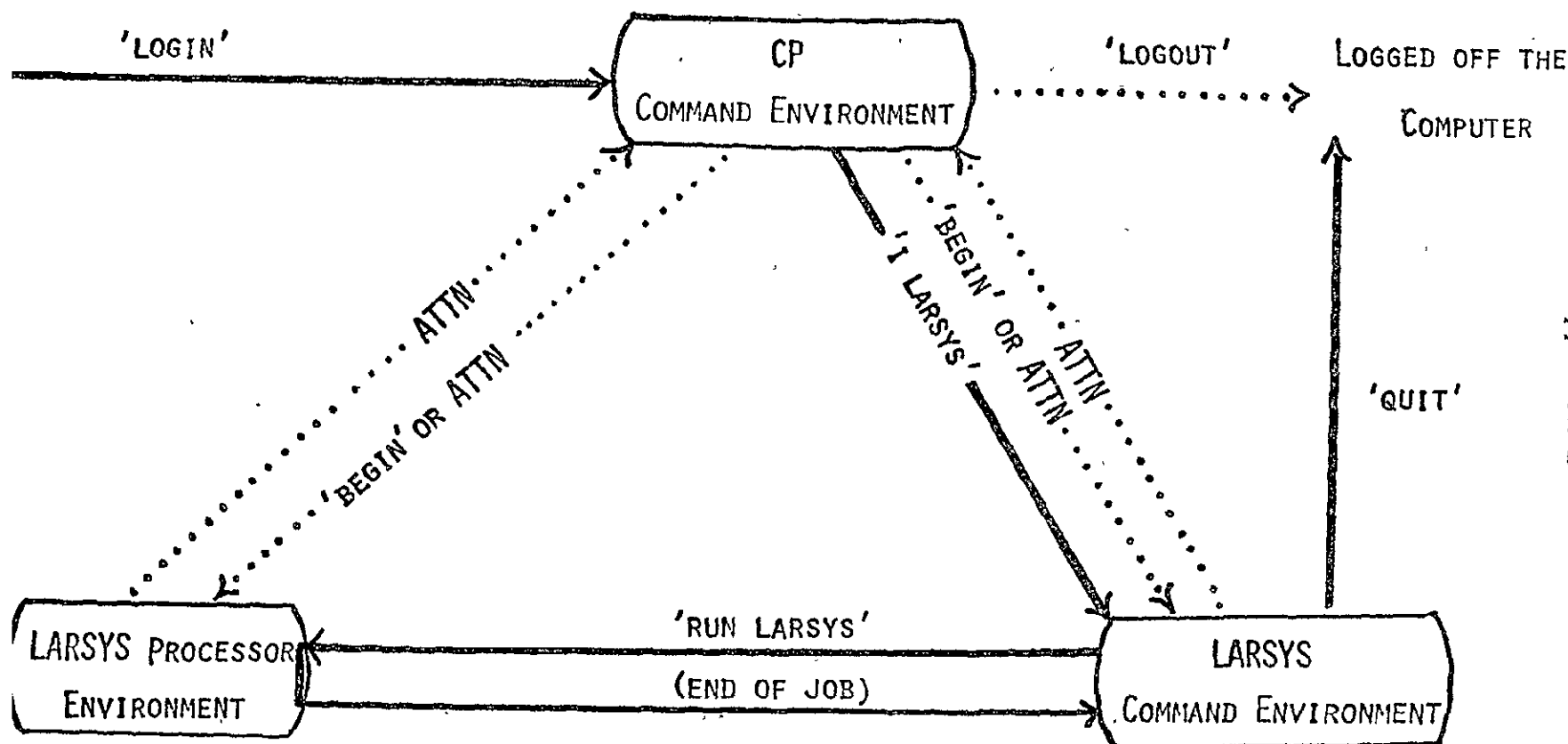
load cards into hopper; ID card must be first card
on reader; make sure HOME MODE light is off, then
push STOP and ABORT buttons
if END OF FILE is not lit, press END OF FILE button
press START
.
.
cards read in
.
.
remove cards from the reader
press RETURN on typewriter to verify transfer of cards

To receive printer output

printer output should be received automatically
if not, check to see that HOME MODE light is off on
reader and START button on printer is lighted,
.
.
printer output received
.
.
press STOP button
press PAGE EJECT four times
remove printer output
press START

To receive punched output

punched output should be received automatically
if not, check to see that HOME MODE light is off on
reader and START button on card punch is lighted
if START button is not lit, push it
if there are not enough cards (several inches thick)
in card punch, load additional cards
.
.
punched output received
.
.
remove punched cards



————— SOLID LINES SHOW NORMAL TRANSITION PATHS
 DOTTED LINES SHOW ALTERNATE TRANSITION PATHS

LARS Computer System Environment Diagram

Materials Required

Problem statements for students
Instructor's Notes

General Instructional Procedure

It is suggested that you assign these problems one at a time and interact with the student between problems.

For each problem the recommended approach is to:

- a) Go over the problem statement with the student.
Discuss which processing function he will be using.
- b) Have student punch the control cards.
- c) Check over the control cards, point out errors or alternative approaches if you wish.
- d) Have student run program.
- e) Discuss results.

Encourage your students to use the LARSYS User's Manual and the LARSYS system features themselves as references. The student may find it helpful if you instruct him how to cancel a job and how to cancel output.

Instructor Time Estimate

Interaction with students before and after each exercise:
10 to 15 minutes per exercise.

Data Source

In all exercises requiring access to a Multispectral Image Storage Tape, the student should be encouraged to use a personal runtable using the card sequence:

```
-RUNTABLE  
DATA  
RUN (XXXXXXXX), TAPE (TTT), FILE (F)  
END
```

See "Special Note to Instructor" on page 6 of A Survey of the LARSYS Educational Package at the beginning of this volume for instructions on how to create the data tape for your site.

Exercise 1: Reference All

This exercise is intended for all students who did not previously get a complete listing of LARSYS Control Commands, Initialization Function Control Cards, and Processing Function Selector and Control Cards.

Log in to the computer, and, after taking care of your ID, password and name and initiating LARSYS, type the command:

reference all

Keep the printer listing for future reference.

Instructor's Notes

1. Check with your student to see that he has a 'Reference All' listing. If he already has one, skip this problem.
2. No control cards are required. Student merely has to review how to login, get his listing and quit.

Exercise 2: LARSYS Control Commands

The purpose of this exercise is to reinforce the login procedure, to give you practice in getting printer output, and to illustrate use of some of the LARSYS Control Commands.

Login and:

- a) obtain the NLWS file pertaining to the system
- b) obtain the SCHEDULE for computer operation
- c) type the command LIST
- d) obtain the RUNTABLE entry for run 72050700

(use your "Reference All" listing to find out which LARSYS Control Command you need to use)

Instructor's Notes

1. *No control cards are required for this exercise. It is designed to give the student practice in the login procedure, issuing control commands and obtaining printer output.*

Exercise 3: Gray Scale Printouts

The purpose of this exercise is to provide experience building an input deck and running a LARSYS job in order to acquire specific output. (See page 2-29 in Volume 1 of the LARSYS User's Manual for general information about card format.) This LARSYS output also illustrates the informational value of multispectral data.

Set up the control card deck needed to obtain a single-width gray scale printout of lines 750-949, run 66000600, showing channels 1 through 12. Use a COMMENT card so that the output will be labeled.

List your deck off-line and check the listing for errors in card preparation. Correct any such errors.

Run the job.

Instructor's Notes

1. *Your student will probably need help in deciding which processing function to use. Try to get him to discover the answer himself, direct him to his REFERENCE ALL output and the LARSYS User's Manual.*
2. *If you have two students doing the exercise at the same time, the output could be reduced by having one run the even channels and the other the odd ones.*
3. *Explain the set-up for a user runtable so that your student will use the tape that has been reserved for instructional purposes at your remote terminal location.*

*For easy reference run 66000600 is stored on Tape TTT = _____;
File F = _____.*

4. *After your student has completed this exercise, you can use his output to illustrate the value of multispectral data. Show how some field boundaries are more easily detected in certain channels.*

LARSYS Exercises

Instructor's Notes
Exercise 3, page 2

5. *Point out how you might want to use the PUNCH control card if you expect to make additional gray scale printouts of the same area. (Saves computing the histograms again.)*
6. *Ask your student if he used the BLOCK card and find out why or why not. Discuss the BLOCK card's function.*
7. *This exercise creates a lot of output. Discuss with your student the need for restricting output requests so that they call for only what is needed.*

Exercise 4: Graph Columns

This exercise and the next are designed to give you more experience with LARSYS and added familiarity with the power of LARSYS for utilizing the multispectral characteristics of the data.

Graph columns 49, 59, 69, lines 408 to 503, of run 66000600. Show data from the .44-.46, .62-.66 and .80-1.00 micrometer channels.

Punch the control card deck and run the job.

Instructor's Notes

1. The problem statement emphasizes the wavelength bands of the channels. Student will have to refer to IDPRINT output to find the corresponding channel numbers.
2. Let the student set up the control card deck. As long as it will work, let it run. Afterwards you may want to point out various ways of setting up the control cards so as to get desired types of graphs (not too many plots on one set of axes, etc.)

For easy reference, run 66000600 is stored on Tape TTT = _____.
File F = _____.

Exercise 5: Graph Lines

The purpose of this exercise parallels that of the previous one with added experience in using a LARSYS diagnostic feature.

Graph line 708 of run 66000600.

Punch the control card deck.

Use the -CHECKOUT procedure to check for control card errors. See pages 5-15 through 5-18 (Volume 1) of the LARSYS User's Manual for a description of this initialization function and pages 3-14 through 3-19 for a step-by-step description of how to use it.

Run the job.

Instructor's Notes

1. *Students will have to decide which channels they want.*
2. *A common blunder is to plot all 12 channels on the same graph. This results in a mass of symbols. Three or four channels per graph works out better.*

*For easy reference run 66000600 is stored on Tape TTT = _____;
File F = _____.*

Exercise 6: Color Panels

The purpose of this exercise is to acquaint you with the batch processing mode and to further your understanding of the nature of multispectral data.

Run 66005200 is a low-level flight over a set of color panels on the ground. These panels are used to obtain data which help in calibrating the aircraft scanner data. The panels, located between lines 400 and 1000 and columns 315 and 425, are arranged in two strips. The strip on the left is made up of three colored rectangular panels; the right-hand one is a series of gray panels.

Using the batch processing mode, obtain some representative gray scale printouts of this area and determine the row and column boundaries of the color panels. See pages 2-45 through 2-46 and pages 3-38 through 3-39 of the LARSYS User's Manual (Volume 1) for information on how to submit a batch run from the terminal.

After you get your gray scale printouts, select a particular panel and obtain lineprinter output of the data values for all points within the panel boundaries. Show the data for a representative set of channels.

Can you tell from the multispectral data the color of each of the three colored panels?

Instructor's Notes

1. Before starting student on this problem be sure a copy of run 66005200 is on the tape dedicated to instructional use at your remote terminal location. If a copy is not available you can make one by running

```
*DUPLICATERUN
FROM RUN(66005200)
TO TAPE(TTT), FILE(F)
END
```

For your future reference:

TTT = _____, F = _____

at this location for run 66005200.

Student should be encouraged to use a personal runtable when running this exercise.

-continued-

2. *This run has only 6 channels. I suggest you let the student stumble into this himself; then point out the value of the ID record (IDPRINT) when working with a new run.*
3. *Student must decide for himself what a "representative" set of channels is. Channel 5 shows the panels quite well.*
4. *The data for line 431 does not exist and, if the parameters selected by the student call for this line, a message to this effect will appear on the gray scale printout. Let the student discover this for himself and use the opportunity to point out the many diagnostic features built into LARSYS.*
5. *Panels are in the vicinity of lines 687-726, columns 340-378. The degree to which the panels show up on the gray scale printouts depends on the size of the area histogrammed.*
6. *The color panels are red, green, and blue in that order.*

INSTRUCTOR'S OVERVIEW
OF UNITS VI, VII AND VIII

Instructor's Notes

At this point in learning to use LARSYS, the student has available three case study units. One case study is geared toward a supervised analysis approach, analyzing aircraft data. The second case study combines techniques from both supervised and unsupervised approaches and applies these techniques to data collected by Landsat. The third is primarily different from the second in that it uses the ECHO (Extraction and Classification of Homogeneous Objects) processor to classify the multispectral scanner data. It also illustrates a slightly different means of developing training statistics.

If a student has the time, resources, and interest, a study of more than one unit is recommended. If not, you should help the student decide which one will be more useful. The philosophy taken in preparing these case studies is described in the "Preface to the Student" section of each document. Please read this material.

In working through any of the case studies, it is important that the students state clearly the objectives of their analyses. Discuss the chosen objectives with the student. A number of readings are suggested from the site library. Make sure that your student knows the local procedures for gaining access to the materials.

We recommend that you monitor the progress of your students frequently. Try to arrange frequent student/instructor conferences of short duration, since experience has shown they are more beneficial than lecture sessions of longer duration. These conferences are particularly important in the case studies analyzing Landsat data.

As the student progresses through one or more case study he will grow in his understanding of analysis techniques. Your role as instructor can be to catalyze that process. At each step of the analysis ask the student to explain why that step was performed and why it was performed the way it was. The discussion might also include how the step could be done differently, and what one might expect if it was done differently. The good student will enjoy experimenting with concepts and parameters and to the extent that resources allow this should be encouraged.

Included in the site library is one solution to each case study. "An Analysis of Run 71053900" is the aircraft data analysis, "An Analysis of Run 73033802" is the satellite data analysis, and "An Analysis of Run 73001011" is available for the ECHO case study. These solutions are NOT presented as "the correct solutions" but rather as example solutions. Since the analysis of remotely sensed multispectral data is a developing science, you should not expect your student's analysis to match the results of the solution we have provided.

Also provided as part of your "instructor's kit" are decks of Field Description Cards for the test fields used in the

INSTRUCTOR' OVERVIEW
OF UNITS VI, VII AND VIII

Instructor's Notes

solutions provided. The test deck for the aircraft data analysis is not intended to replace student-selected test fields, but rather to serve as an additional evaluation tool if, for instance, several students are going through at once and you want a comparison test deck. The test deck for the satellite data analysis is provided for use by all students, to save them the time they would spend selecting their own test fields. The same is true for the ECHO case study.

GUIDE TO MULTISPECTRAL DATA ANALYSIS USING LARSYS

Instructor's Notes

Materials Required

1. Student copy of Guide to Multispectral Data Analysis using LARSYS by J.C. Lindenlaub (LARS Information Note 062873)
2. Student copy of Pattern Recognition Notes by P.H. Swain (LARS Information Note 111572)
3. Reference copy of LARSYS User's Manual
4. Reference copies of LARS Information Notes:
 - 120371 - The Importance of Ground Truth Data in Remote Sensing by R.M. Hoffer
 - 102670 - Random Noise in Multispectral Classification by S. Whitsitt
 - 062273 - Analysis Research for Earth Resource Information Systems: Where Do We Stand? by D.A. Landgrebe
 - 020871 - Comparison of the Divergence and β -Distance in Feature Selection by P.H. Swain, T.B. Robertson and A. Wacker
5. "An Analysis of Run 71053900" with Field Description Cards for test fields.
6. Multispectral Image Storage Tape: Check to see that one of the data tapes assigned to your terminal site has a copy of run 71053900 on it. If it does, enter the tape number and file number below for easy reference:
Tape TTT = _____; File F = _____
If it does not, see page 6 of A Survey of the LARSYS Educational Package.

Additional References

Examples of results analysis and the extraction of useful information from multispectral data classifications may be found in journals such as:

Remote Sensing of the Environment
IEEE Transactions on Geoscience Electronics
Remote Sensing in Ecology
Journal of Soil and Water Conservation
Photogrammetric Engineering and Remote Sensing
Agronomy Journal
Applied Optics

as well as in a number of LARS Information Notes, and published proceedings of remote sensing conferences.

Instructor's Notes

The philosophy taken in preparing this part of the LARSYS Educational Package is described in the "Preface to the Student" section of the document. Please read this section.

It is suggested that you monitor the progress of your student frequently - you should plan on talking to him at least once during each step of the analysis sequence. Experience indicates that frequent student/instructor conferences of short duration are more beneficial than longer duration lecture sessions.

Students need to state their objectives clearly for the case study.

Each remote terminal site has been provided with a copy of "An Analysis of Run 71053900." The analysis of remotely sensed multispectral data is a developing science and you should not expect your student's analysis to match the results of the "school solution" we have provided. There is no single "correct" analysis. In particular, it is doubtful that a person analyzing a flightline for the first time would obtain as high a degree of correct classification as has been achieved on the analysis provided to you. Consider our solution a "crutch" but not an "authority."

A CASE STUDY USING LARSYS FOR
ANALYSIS OF LANDSAT DATA

Instructor's Notes

Materials Required

1. Student copy of A Case Study Using LARSYS for Landsat Data by Tina K. Cary and John C. Lindenlaub (LARS Information Note 050575)
2. Student copy of Pattern Recognition: A Basis for Remote Sensing Data Analysis by Philip H. Swain (LARS Information Note 111572)
3. Reference copy of LARSYS User's Manual
4. Reference copies of LARS Information Notes:
 - 120371 - The Importance of Ground Truth Data in Remote Sensing by R.M. Hoffer
 - 011069 - Ecological Potentials in Spectral Signature Analysis by R.M. Hoffer and C.J. Johannsen
 - 042673 - Two Effective Feature Selection Criteria for Multispectral Remote Sensing by P.H. Swain and R.C. King
 - 062873 - Guide to Multispectral Data Analysis Using LARSYS by J.C. Lindenlaub
 - 110474 - An Introduction to Quantitative Remote Sensing by J.C. Lindenlaub and J.D. Russell
 - 072473 - Emission and Reflectance from Natural Targets by R. Kumar and L. Silva
 - 100771 - The Minimum Distance Approach to Classification by A.G. Wacker and D.A. Landgrebe
5. "An Analysis of Run 73033802" with field description cards for test fields.
6. Reference Data: Three kinds of reference material are needed for the case study:
 - a) Six U.S. Geological Survey 7.5 minute quadrangle maps covering the area analyzed in the case study. These are not provided as part of the site library. The site techniques specialist should be responsible for ordering these maps. Three or more sets of maps per site are recommended. The maps may be ordered from Distribution Section U.S. Geological Survey, 1200 South Eads Street, Arlington, Virginia, 22202. The names of the sheets required are:
 - Oolitic, Indiana
 - Bartlettsville, Indiana
 - Clear Creek, Indiana
 - Allen's Creek, Indiana
 - Bloomington, Indiana
 - Unionville, IndianaA set of the USGS maps should be loaned to the students during their study and collected from them afterward.

- b) Monroe County, Indiana highway maps. Ten of these are provided per site. They are to be lent to the students during their study and collected from them afterward.
 - c) Color infrared aerial photograph in 35 mm slide format. Ten slides are provided for each site. Again, they are intended to be loaned to the students and collected from them upon completion of the case study.
7. Multispectral Image Storage Tape: Check to see that one of the data tapes assigned to your terminal has a copy of runs 73033802 and 72072302 on it. If it does, enter the tape number and file number below for easy reference:
- 73033802 Tape TTT = _____; File F = _____
72072302 Tape TTT = _____; File F = _____
- If it does not, see page 6 of A Survey of the LARSYS Educational Package.

Additional References

Examples of results analysis and the extraction of useful information from multispectral data classifications may be found in journals such as:

Remote Sensing of the Environment
IEEE Transactions on Geoscience Electronics
Remote Sensing in Ecology
Journal of Soil and Water
Photogrammetric Engineering and Remote Sensing
Agronomy Journal
Applied Optics

as well as in a number of LARS Information Notes and published proceedings of remote sensing conferences.

Instructor's Notes

As mentioned earlier, student/instructor interaction is an important part of this case study. It is recommended that you meet with your students after each step in the analysis. At the beginning of the case study you will want to make sure that each student knows about the various reference materials and their availability.

ANALYSIS FLOWCHART

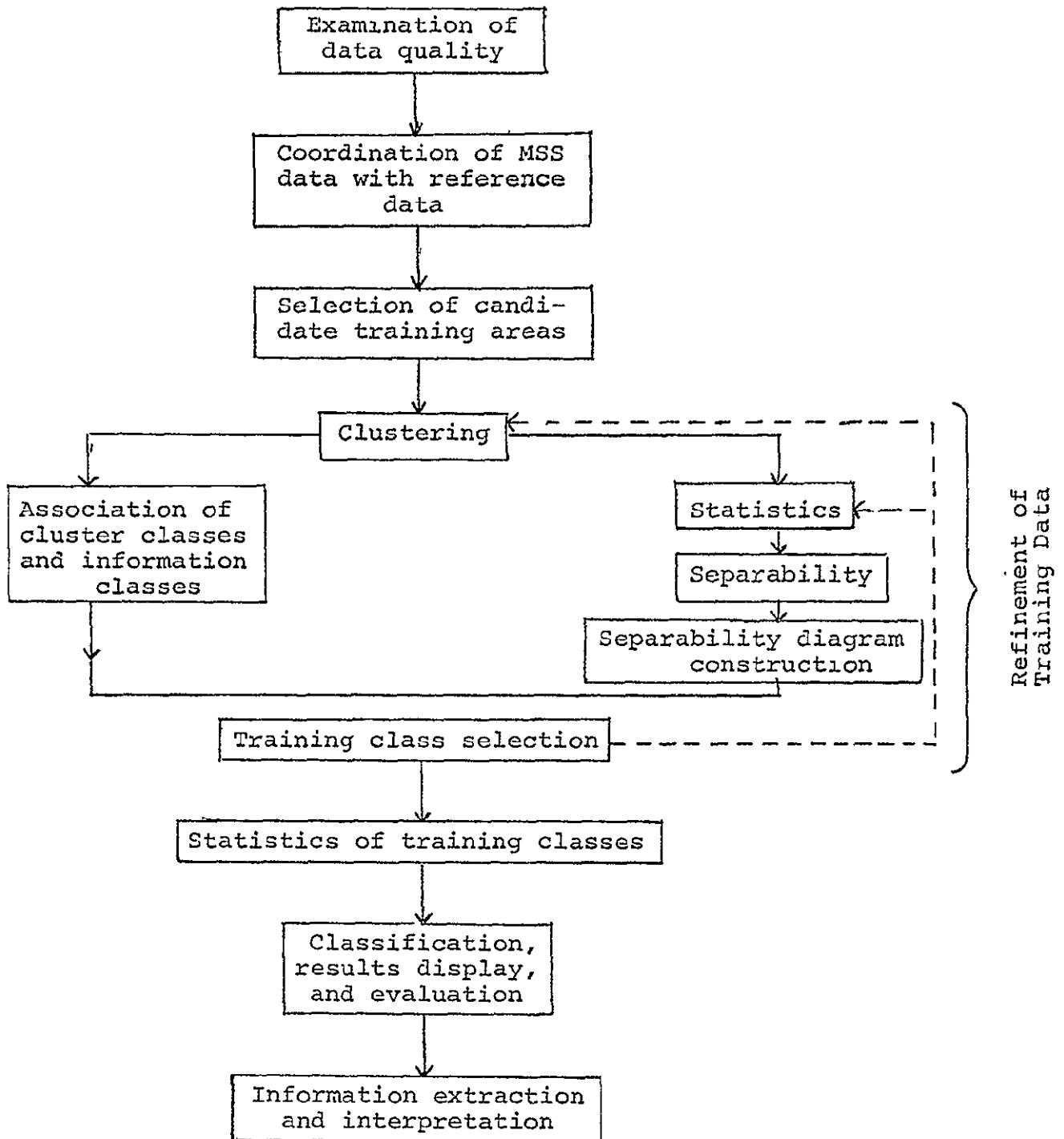


Figure 2. Flowchart indicating the sequence of steps undertaken in the analysis procedure described in this manual.

The following comments relate to the analysis flowchart for the case study which is reprinted on page three for your convenience.

In the examination of data quality and coordination of the multispectral scanner data with reference data, the student is told in the case study that the data tape he will be working with has been geometrically corrected and scaled to match the scale of the USGS 7.5 minute quadrangle maps. However, no mention has been made of the fact that in order to get proper matching a double printout employing every line and column should be used. It might also be helpful for you to know that if every other line and column is used, the scale approximates the scale of the Monroe County highway map.

The case study material suggests in the section on selecting training areas that each training area should contain more than one cover type. Some students will perhaps inquire why you can't select areas that are "pure" in the sense that they contain only one cover type. An obvious example here is to select an area from the middle of the reservoir which is certain to contain only the water cover type. Although this procedure can be used to carry out the case study, it is suggested that you encourage students to include more than one cover type. The reason for doing this is: when the clustering algorithm uses all four channels of data, the cluster map which is produced may be thought of as an enhanced image. That is, a map obtained by using data from all four bands might be expected to do a better job of delineating boundaries between cover types than any single-channel gray scale map. An area which includes a fairly large portion of the reservoir along with some shoreline area should illustrate this point.

It is suggested that you place the burden of decision upon your students in selecting candidate training areas. There are a number of approaches, and some work better than others, but we have found that students gain by their mistakes and seldom make the same mistake twice. Examples of typical blunders in selecting candidate training areas are the following:

a) Selecting areas on gray scale printouts and then discovering later on that the areas that they selected happened to fall in the cloud shadow area of the aerial photograph, thus making it impossible to establish cluster-class/information-class associations.

b) Not selecting areas with distinctive geometric features, such as a bend in the river or a peninsula jutting out into the reservoir, thereby making the process of overlaying the aerial photograph and the cluster maps more difficult.

Here again, it is suggested that you let students discover these errors for themselves. If they don't use the best

techniques the first time, you can point out some of their weaknesses and suggest improved techniques for use in future analyses.

It would be a good idea to discuss with your students the analysis flowchart after they have completed the clustering operation. As the case study is written, students are encouraged to make cluster-class/information-class associations working from the output of the cluster maps and reference data before running the STATISTICS and SEPARABILITY processors. You might want to point out that it would be possible to proceed on the right-hand branch of the analysis flowchart, that is the statistics, separability diagram construction prior to the time that they make the spectral class/information class associations. Experience with pilot groups of students has indicated that until the students have actually pursued both paths they don't have a full appreciation of the interdependency of these operations.

Although the case study points out that the students should take care in keeping track of the symbols used in SEPARABILITY and being able to relate them to the original cluster symbols, it would not hurt to emphasize this point with them before the SEPARABILITY processor is run.

Interpretation of the separability diagram and final training sample selection will be one of the most frustrating experiences for the students. Your encouragement at this point would be helpful. It must be realized however, that there are no clear-cut, crisp rules that can be used in this part of the analysis. Also, take this opportunity to state that part of the purpose of the case study is to develop experience. If there were strict rules available, it would not be necessary to have highly trained analysts.

In discussing the classification and results display operations with your students, point out that the case study suggests storing the classification results on disk and hence, it is suggested that the students chain several PRINTRESULTS runs immediately after the CLASSIFYPOINTS algorithm has been run. One possibility is to do a PRINTRESULTS which does not group any of the subclasses which they may have defined. This allows students to see the interdependency between the various subclasses. Then follow this with a second PRINTRESULTS operation which groups subclasses into the major cover types so that the test deck which has been provided as part of the case study materials may be used.

Out of seven groups of students that have field-tested this study most of them achieved training data performance results in the low to mid 90% range. Most of the groups achieved test results percentages in the low to mid 80's with considerable confusion between the urban and agricultural classes and to a lesser extent confusion between the forest and agricultural classes. These numbers are given simply

as guidelines. It is certainly possible that a student who achieved only 60% accuracy could learn as much about the case study as a student who achieved an 87% accuracy.

The interpretation of classification results should be discussed with your students. When low accuracies and confusion between certain cover types are evident in the results, this could also arise because the training sets that were finally chosen were not representative of the area being classified. If the situation warrants it and time permits you may wish to have your students iterate through portions of the analysis again.

A CASE STUDY USING ECHO
FOR ANALYSIS OF MULTISPECTRAL SCANNER DATA

Instructor's Notes

Materials Required

1. Student copy of A Case Study Using ECHO for Analysis of Multispectral Scanner Data by Donna Scholz, James Russell, John Lindenlaub and Philip Swain (LARS Information Note 909177)
2. Reference copy of LARSYS User's Manual edited by T.L. Phillips
3. Reference copy of ECHO User's Guide edited by James Kast
4. "An ECHO Analysis of Run 73001011" with field description cards for test fields.
5. Reference copies of LARS Information Notes:
 - 110474 - An Introduction to Quantitative Remote Sensing by J.C. Lindenlaub and J.D. Russell
 - 111572 - Pattern Recognition: A Basis for Remote Sensing Data Analysis by P.H. Swain
 - 062375 - Classification of Multispectral Image Data by Extraction and Classification of Homogeneous Objects by R.L. Kettig and D.A. Landgrebe
 - 121275 - Computer-Aided Analysis of SKYLAB Multispectral Scanner Data in Mountainous Terrain for Land Use, Forestry, Water Resources and Geologic Applications by R. Hoffer
6. Reference Data: Two kinds of reference material are needed for this case study.
 - a) Four U.S. Geological Survey 7.5 minute quadrangle maps covering the western side of Indianapolis, Indiana, for use in the Exercises. These are not provided as part of the site library. The site techniques specialist should be responsible for ordering these maps. Three or more sets of maps per site are recommended. The maps may be ordered from:

Distribution Section
U.S. Geological Survey
1200 South Eads Street
Arlington, Virginia 22202

The names of the maps required are:

Clermont, Indiana
Indianapolis West, Indiana
Bridgeport, Indiana
Maywood, Indiana

A set of the USGS maps should be loaned to the students during their study and collected from them afterward.

- a) Six color infrared aerial photographs. The prints should be loaned to the students and collected from them upon completion of the case study. sets of prints are provided as part of the site library.
7. Multispectral Image Storage Tape: Check to see that one of the data tapes assigned to your terminal has a copy of run 73001011 on it. If it does enter the tape number and file number below for easy reference:

73001011 Tape TTT = _____; File F = _____

If it does not, see page 6 of A Survey of the LARSYS Educational Package, which is part of Unit I of the Educational Package.

8. Intermediate results tape - Tape 920. A copy may be made using the *COPYRESULTS function in LARSYS.

Instructor's Notes

Student/tutor interaction is an important part of this case study. It is recommended that you meet with your students after each step in the analysis. At the beginning of the case study you will want to make sure that each student knows about the various reference materials and where to secure them.

It should be pointed out that even though the Exercises which give the students "Hands-On" experience using the computer for an ECHO analysis come at the end of the case study, the corresponding Exercises can be done after each section of the case study and its associated example. In trying out this case study with students it was found that the students preferred going entirely through the discussion of ECHO and the examples before doing the Exercises, hence this format was used. Perhaps you will want to try both ways with your students and determine which they tend to prefer.

Two possible study sequences:

SEQUENCE A

Section I
Section II
Section III
Section IV
Section V
Exercise 1
Exercise 2

SEQUENCE B

Section I
Exercise 1
Section II
Exercise 2
Exercise 3
Section III
Exercise 4

Exercise 3	Exercise 5
Exercise 4	Exercise 6
Exercise 5	Exercise 7
Exercise 6	Exercise 8
Exercise 7	Section IV
Exercise 8	Exercise 9
Exercise 9	Exercise 10
Exercise 10	Section V
Exercise 11	Exercise 11

The following comments relate to the generalized steps in classifying earth resources data as shown in Figure 6 of the case study and reproduced on the next page.

Section I - Discuss with each student the objective that he wrote for Self-Check I-B. This is also a good time to determine if he has any questions about the case study thus far.

Section II - Discuss with the student his answers to the self check to determine if he has any questions on the material presented thus far.

Section III

•Cluster Analysis: At this point the student may be confused as to how many clusters should be requested from a training area. The number of clusters chosen typically ranges from 1.5 to 2.0 times the number of covertypes present. The rule could be stated as: use 2.0x when counting only major covertypes, e.g., agriculture, wooded, residential, commercial, etc.; use 1.5x when subcategories are counted, e.g., soybeans, corn, deciduous, coniferous, new residential, old residential, etc. However, situations will arise in which after doing the clustering, a more optimum number of clusters will be suggested, as is reviewed on page 25 of the text.

•Association of cluster classes with information classes: the student should be asked what "these data" at the last of the fourth paragraph on p.37 refers to. Although it may be true that the cover types cannot be separated using the current data set (i.e., Landsat frame) it may only be necessary to ask for a larger number of clusters to separate them.

•Calculation of statistical distance between clusters: in the example in this section the suggested groupings from the grouping table at the end of the cluster output were utilized. The student should understand that the advice of that grouping table should only be taken when it suggests grouping classes of similar informational identity. An additional reason for scrutinizing the suggested grouping is that it is

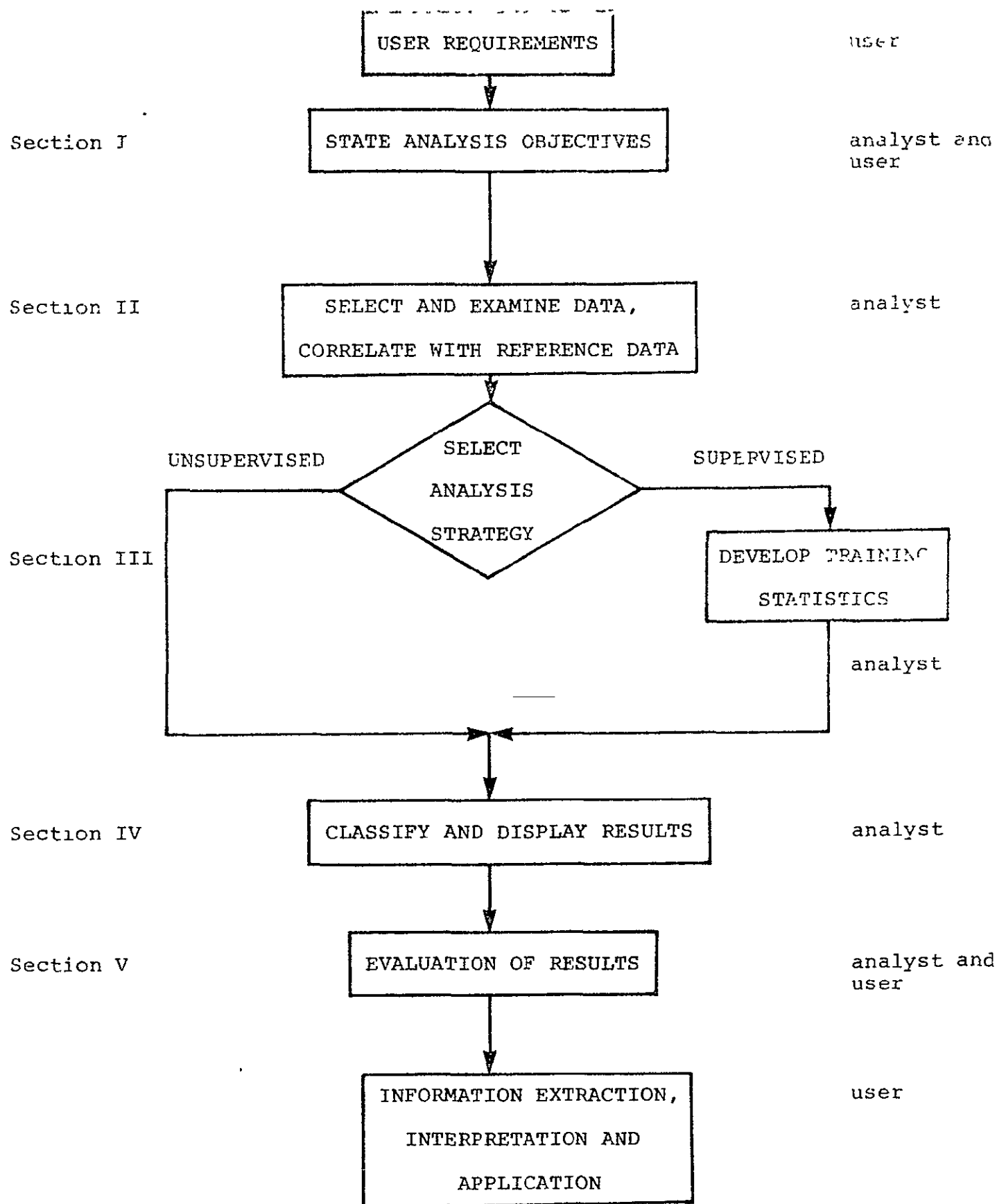


Figure 6: Generalized Steps in Classifying Earth Resources Data

entirely possible for another class from a different training area to be more like any of the classes the grouping table is suggesting grouping.

Also in the example a transformed divergence threshold of 1000 is used for the grouping table from SEPARABILITY. This is a rule of thumb suggested to prevent the student from getting suggested groupings of obviously different covertypes. Other larger values are possible and may be preferable.

Finally, in the example, the grouping table at the end of the SEPARABILITY output is accepted without question, the classes are grouped accordingly, and the resulting statistics deck is used to make the classification. This is a valid method, but not the only method, you may want the student to review pp.59-108 of the Landsat case study to get a different perspective.

Section IV - Discuss the ECHO classifier and the parameters necessary to run it with the student. It might be desirable to discuss how classifying a group of points instead of individual points could lead to higher classification accuracy.

Section V. - There are a few places in the data where test fields should not be picked, such as within training areas and over bad lines. Discuss this and the other criteria mentioned in the text with the student. In addition it might be useful to discuss the fact that training field accuracy is a measure of the separability of the training classes while test field accuracy indicates the representativeness of the training classes.

Exercise 1 - By now the student should not have too much difficulty accomplishing this. Discuss with him the user's requirements and insure that he understands the classes which are most important to separate. It may be beneficial to suggest 70% as the accuracy desired.

Exercise 2 - Let the student determine what a "representative set of channels" is and discuss his decision with him. Also he may not be aware that in order to obtain his grayscale maps at the same scale as the 7.5 minute topographic maps a line and column interval of one must be used. This necessitates getting a triple width printout, which he may need instruction on how to assemble.

Exercise 3 - It is important to emphasize that in this step the student's primary goal should be to gain familiarity with the study area and the location of landmarks on the grayscale maps. When he has completed this exercise he should be able to point out the general location of commercial, industrial, residential, and agricultural areas as well as the major landmarks.

It may be necessary to point out that although the text of the exercise begins by talking about means of referencing cluster maps and photos, that will be done in a later exercise. However, the techniques discussed are useful anytime two pieces of information must be compared with one another.

Exercise 4 - Analysis tasks vary greatly in the amount and quality of reference data that is available. This always has a significant impact on the objectives of the analysis. This case study is an example of an analysis task where the reference data is of good quality but limited to six aerial photographs and topographic maps which are 10 years old. It is suggested that you allow the student the chance to discover this and decide how it impacts the task before him on his own. He may go ahead and select his training areas or he may approach you with questions. In general it is best to have him pick the training areas on his own with a minimum of input from you. In this way students can learn from obvious mistakes, such as

- a) Selecting training areas not covered in any aerial photography. In some cases this might be acceptable, however, the topographic maps are several years out of date and lack specificity, thus making correct identification of training classes later on difficult or impossible.
- b) Selecting training areas that do not have distinctive landmarks, making exact location of the training area in the reference data much more difficult.

Although up to date reference data is limited to the six photographs, and it is strongly recommended that the training

areas be selected within them, the student still has some options:

- a) It is not necessary to use all six photos as the training areas, a subset will suffice.
- b) It is possible to use only parts of the photos as training areas. However, care should be taken to insure that the training areas selected are large enough to represent all the possible conditions of the covertypes present.

Exercise 5 - If this is the second case study your student has done he may be counting subcategories as covertypes, in which case he should request 1.5x clusters. If time and resources allow, permit the student to test his reasoning by using the numbers he arrives at and then going back and trying a different number of clusters if he is not satisfied with his first set.

In the example in the text statistics on the resulting clusters were punched for use in later steps. Ask the student to explain why it is necessary to punch the statistics before he knows if he will use them or not. His answer should include the concept that the machine 'forgets' what the clusters were when the job finishes.

Exercise 6 - The student should understand that when he is done associating his cluster classes with the reference data he should have a description of what each cluster represents on the ground. Some students become confused when two or more cluster maps have the same symbols, as if the classes with the same symbols should represent the same coertype. Therefore, it may be a good idea to underscore that each training area was clustered individually and that therefore clusters represented by the same symbol do not necessarily need to represent the same coertype. Encourage the student to do as much as possible on his own, but don't hesitate to demonstrate the process or assist him if he has difficulties.

Exercise 7 - Query the student to insure he understands that the grouping table is merely an aid and does not have to be exactly followed, especially when it suggests grouping clusters representing different coertypes.

In order to use the MERGESTATISTICS function and the SEPARABILITY function that produces a grouping table on the basis of transformed divergence it is necessary to either IPL LARSYSDV at the terminal or insert the I LARSYSDV card behind the normal batch job cards. For example:

```
ID          BATCH
BATCH MACHINE BATSHORT
BATCH ID TECTRA DONNA SCHOLZ
BATCH OUTPUT COMPUTER COMPUTER
I LARSYSDV
```

```
*MERGESTATISTICS
,
:
:
:
END
```

The MERGESTATISTICS control cards are available from the terminal by IPL'ing LARSYSDV and typing REFERENCE MERGESTATISTICS. The student may need help with the pool cards.

Exercise 8 - If time allows have the student experiment with different transformed divergence thresholds so he may see what is grouped in each case. In addition it may be desirable for him to draw a separability diagram. See pages 59-108 of the Landsat case study.

Exercise 9 - As ECHO is a developing processor, its control cards may change from time to time, current control card listing for SECHO is available from LARSYSDV in the same manner as for MERGESTATISTICS and SEPARABILITY. When generating intermediate results it is necessary to specify an intermediate tape and file number, not a results tape and file number. SECHO may be ran on LARSYSDV at the terminal or by batch in the same manner as MERGESTATISTICS and SEPARABILITY.

The following intermediate results for the Indianapolis area are available for the student to experiment with.

Tape 920

File 1	Cell size 2x2	Homogeneity Threshold	20.0
File 2	Cell size 2x2	Homogeneity Threshold	40.0
File 3	Cell size 2x2	Homogeneity Threshold	60.0
File 4	Cell size 2x2	Homogeneity Threshold	80.0

It is highly desireable for the student to experiment with these parameters and different annexation thresholds. If he uses the intermediate results already available this will not consume a large amount of computer time.

Exercise 10 and 11 - The student will probably want to try different symbol combinations. It would be most efficient to have him determine his classification accuracy at the same time he is making a display map.

Have the student select a set of test fields using the topographic maps and any of the aerial photographs he did not use as training areas. Have him use the ones he selects to evaluate the classification. It is possible to group training classes for testing. For example the hypothetical classes Urban1 and Urban2 could be tested against a single set of urban test fields if they were grouped for testing using the group option in PRINTRESULTS.

Discuss with the student reasons for differences in his

accuracy figures using his test fields and those supplied with the site library. A set is supplied with the site library to provide a benchmark against which the student's test fields can be compared and to allow student to student comparisons. Typical accuracies for a new student are in the neighborhood of 70%. It is not necessary for the student to repeat the analysis if his accuracy is lower than this. It is quite possible that a student achieving 80% accuracy would learn just as much as one achieving 60% accuracy. Nevertheless it would be good for the student to consider what he could do differently that would increase his accuracy.

Summary - As the main thrust of this case study is to broaden the students knowledge of analysis, the instructor should help the student to consider how and why some analysis steps may be done differently and where a given approach is most appropriate. People who understand those things will be the most valuable when it comes time to apply what they have learned.